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CLINICAL PROBLEM OF ALLERGY IN RELATION TO CONJUNCTIVITIS AND IRITIS

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The importance of allergy, or an altered state of reactivity to specific agents, has been stressed repeatedly in the recent ophthalmic literature. Much of this literature deals with purely experimental lesions of the eye, and a small amount deals with clinical investigation. Rather broad deductions appear to have been made from these experimental and clinical findings, and at present clinical ophthalmologists are constantly confronted with the questions of therapeutic desensitization and various forms of vaccine treatment for patients with inflammatory lesions of the conjunctiva and anterior part of the uveal tract.

I have no wish to minimize the importance of allergic reactions in these conditions. However, the questions involved are complicated and in many instances not clearly understood, and often lie more in the domain of the immunologist and of the bacteriologist than in the province of the ophthalmologist. It is my purpose in this paper to outline, from the point of view of the ophthalmologist, the present state of knowledge on the relation of allergy to conjunctivitis and iritis and to indicate the clinical application of this knowledge.

ALLERGY AND CONJUNCTIVITIS

A large number of authors—Koutseff,[1] LaGrange and Delthil,[2] Krückmann,[3] Berneaud,[4] Blake,[5] Dejean and Temple,[6] and numerous others—have reported cases of allergic conjunctivitis. Koutseff divided

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1. Koutseff, A.: Contribution à l'étude des conjonctivites allergiques non infectieuses, Zentralbl. f. d. ges. Ophth. **33**:333, 1935; Les conjonctivites allergiques non infectieuses envisagées dans le cadre des allergies en général, Bull. Soc. d'opht. de Paris, April 1935, p. 267.

2. LaGrange, H., and Delthil, S.: Les réactions allergiques de la conjonctive oculaire, Ann. d'ocul. **170**:1009 (Dec.) 1933.

3. Krückmann, E.: Ueber Allergie in der Augenheilkunde, Klin. Monatsbl. f. Augenh. **92**:809, 1934.

(Footnotes continued on next page)

allergic conjunctivitis into two distinct clinical types, both due to direct contact of the sensitized conjunctiva with the specific allergen. The first is the sudden, edematous type, characterized by a sudden onset, edema, conjunctival congestion and lacrimation. Koutseff stated the belief that this is due to allergens suspended in the atmosphere, notably the pollens. The second is the follicular, eczematous type, which comes on slowly, characterized by eczema of the lids and neighboring skin, and is produced most frequently by drugs such as butyn, atropine and the various collyria and salves. LaGrange and Delthil [2] described three types: first, a transitory form, characterized by edema of the palpebral and bulbar conjunctiva, which is sudden in both its appearance and its disappearance; second, chronic blepharoconjunctivitis, with a tendency to eczema of the lids, and, third, a chronic follicular type. LaGrange and Delthil [2] stated the belief that the endocrine glands and the vegetative nervous system are concerned in cases of allergic conjunctival disorders. Krückmann [3] likewise expressed the opinion that there are three types of allergic conjunctivitis. The first is the sudden, edematous type, more or less strictly localized, associated with glassy edema of the conjunctival fold, without redness of the margins of the lid or evidence of furunculosis or hordeolum, which is sudden in both its appearance and its disappearance; the second is blepharoconjunctivitis associated with eczema of the lids, and the third is simple hyperemia that lasts for weeks, without much secretion of mucus. Krückmann expressed the belief that vernal conjunctivitis occupies a special position. He also made the point that the conjunctivitis that appears in hypersensitive persons after the ingestion of certain foodstuffs, notably shell-fish and lentils, is indistinguishable from the conjunctivitis produced at times by atropine. This classification of three types of allergic conjunctivitis is excellent, but the clinical appearance gives only a slight hint as to the nature of the causative allergen, which may be pollen, animal dust, food, or bacterial toxins or their derivatives.

The best known example of the sudden edematous type of allergic conjunctivitis is that seen in association with asthma and hay fever. The mucous membrane of the eye, the conjunctiva, participates in the general hypersensitivity of the mucous membranes of the upper respiratory passages and, like them, reacts with sudden inflammatory edema when in contact with the specific sensitizing substance, the air-suspended allergens. There are usually chemosis of the palpebral and bulbar conjunctiva, congestion, profuse lacrimation and a nonpurulent secretion without bacteria. The attack subsides quickly after the instillation of epinephrine hydrochloride.

4. Berneaud, G.: Allergische Augenerkrankungen, Ztschr. f. Augenh. **78**:193, 1932.

5. Blake, E. M.: Allergic Reaction of the Eyelids, Arch. Ophth. **53**:272, 1924.

6. Dejean, C., and Temple, J.: Some Special Cases of Follicular Conjunctivitis, Bull. et mém. Soc. franç. d'opht. **46**:143, 1933.

The classic example of the edematous, eczematous type of allergic conjunctivitis is that caused by drugs. This presents little diagnostic difficulty. The eczematous cutaneous reaction and edema of the lids, the profuse lacrimation and the conjunctival congestion, usually associated with a slight degree of chemosis, present a characteristic picture. The offending drug can usually be identified without difficulty, for patients use few drugs in their eyes. This type of conjunctivitis is always accompanied by marked generalized hypersensitivity of the skin, which can be demonstrated by the ordinary patch test—the application of a salve containing the drug to the skin of the leg, this area then being covered with a bandage for twenty-four hours. If the patient is hypersensitive to the drug, marked dermatitis will occur at the site of application. By this test a suspected sensitivity can be determined before a drug is used. An occasional patient is sensitive to the oily base usually employed in salves. This type of conjunctivitis subsides slowly, in several days, after the withdrawal of the offending drug. A drug that is entirely innocuous on first administration may gradually acquire the properties of a sensitizing allergen. Landsteiner [7] showed that simple inert substances, even metals, may combine with native protein to form sensitizing substances. This is probably the explanation for the development of hypersensitivity to drugs by the conjunctiva. The offending drug, in contact with the lacrimal secretion, forms a foreign compound capable of producing the specific sensitization.

The third type of allergic conjunctivitis is chronic, recurrent, irritative conjunctivitis, often associated with low grade folliculosis, with rather sharp exacerbations and with consistently normal bacteriologic findings. The responsible allergens may be pollens, animal dust, foods or bacterial allergens. The detection and demonstration of the responsible allergens present a difficult diagnostic problem. Attention is drawn to such an etiologic possibility by the clinical picture of the condition, the normal character of the bacterial flora, the resistance of the conjunctivitis to ordinary treatment, such as astringents and collyria, and the correction of refractive errors and muscular anomalies. In this type of conjunctivitis the conjunctival reaction is often the only clinical evidence of tissue allergy.

The first step in the detection of the responsible allergen or allergens is a careful taking of the history. Are there other allergic manifestations; is there a history of allergy in the patient or the family, and was there any constant common factor in the patient's life and diet previous to the exacerbation? The second step is to test the patient against the specific individual and group allergens.

The best test for specific sensitivity is the intracutaneous injection of specific allergens. This is less misleading in its results and permits

7. Landsteiner, K.: Experiments on Anaphylaxis to Azoproteins, J. Exper. Med. **39**:631, 1924.

greater accuracy than does the scratch method. The usual diagnostic dose of pollens, foods and animal dusts is 0.03 cc. The diagnostic intracutaneous dose of bacterial toxins is 0.1 cc. of different dilutions. The reactions are read in fifteen minutes. Several tests can be made at one time. There are two distinct major groups of allergens against which the patient must be tested: first, the group comprising the pollens, foods and animal dusts, and a few specific allergens, and, second, the bacterial toxins.

Specific Allergens.—The first general group of allergens, the pollens, foods and animal dusts, may be divided into twelve subgroups: the common pollens, the tree pollens, the rare pollens, epidermals and inhalants, vegetables, fruits, grains and spices, dairy products, meats, sea food and nuts, and special allergens, such as intestinal parasites, silk and rayon. Each of these subgroups contains from five to twenty-two allergens, in all, but one hundred and forty different substances against which the patient must be individually tested, often with different dilutions. In addition to these twelve groups, there are two other groups of composite antigens, made up of botanically related foods. In these two groups there are eighteen composite antigens, some containing as high as eight allergens. If a patient is sensitive to one of these group allergens he must be tested against each of the individual components of the group.

It is therefore apparent, when one considers the great number of allergens necessary to determine a suspected hypersensitivity and the complexity of the task involved, that such a study is beyond the province of the clinical ophthalmologist. The patient must be referred to an immunologist for the determination of the allergic status as regards the pollens, foods, animal dusts and inhalants. When such a study has been completed, the ophthalmologist is faced with the problem that the patient often shows a multiple sensitivity; that is, he is sensitive to a number of widely different allergens. There is also some evidence that cutaneous sensitivity and conjunctival sensitivity may not be parallel. Frequently, therefore, it must be determined to which allergen, if any, there is an especial conjunctival sensitivity. This is determined by the ophthalmic test, the instillation into the conjunctival sac of a 1:10 or 1:100 dilution of the various allergens to which cutaneous sensitivity has been demonstrated. The eye should be quiet and the corneal epithelium intact, lest allergic keratitis be produced. A positive ophthalmic test is evidenced by prompt conjunctival congestion and lacrimation. If such a test is positive, the eye should be immediately irrigated and a drop of solution of epinephrine hydrochloride instilled.

After a diagnosis of allergic conjunctivitis due to sensitivity to pollens, foods or animal dusts, there arises the question of treatment. Theoretically, desensitization by repeated subcutaneous injections of the

specific allergen is indicated. However, the length of time necessary to achieve such desensitization, the tendency of the hypersensitivity and symptomatology to recur and the uncertainty of obtaining complete conjunctival desensitization are discouraging factors. The knowledge of ocular therapy is not yet advanced sufficiently to warrant the attempt at local desensitization by such methods as repeated local administration of the specific allergens. To my mind, the most important step is the education of the patient to avoid the specific intoxicating allergen. Thus, a patient with a cutaneous and conjunctival hypersensitivity to feathers must be taught to keep rigorously away from all poultry and birds and to sleep on a kapok pillow, while a patient with food allergy must be cautioned to abstain from the specific food. The change in the clinical picture of the eyes after such simple advice is followed is often astounding. The only local treatment indicated is cleansing the eyes with any bland collyrium or salt solution and the use of weak astringents with a little epinephrine added. Until it is demonstrated that such expectant treatment is unpractical or without avail I do not feel justified in undertaking specific desensitization.

Bacterial Toxins.—Staphylococcus Toxin: The second large group of allergens are the bacterial toxins and nucleoproteins. The most important of these, from the standpoint of the ophthalmologist, is staphylococcus toxin. With a small amount of training an abnormal hypersensitivity to staphylococcus toxin can be determined by the ophthalmologist himself. Studies with other toxins and studies with bacterial proteins lie in the domain of the bacteriologist.

While staphylococcus toxin is lethal in small doses, it is not in itself irritative to a normal skin or normal mucous membrane. It produces irritative symptoms only in hypersensitive tissues. The probable mechanism of conjunctivitis due to staphylococcus toxin may be conceived of as follows: infection with a toxin-producing staphylococcus is followed by local absorption of the toxin and resultant tissue hypersensitivity. Fluctuation in the growth of the infecting bacteria is accompanied by changes in the toxin formation. The absorption of toxin by the hypersensitive conjunctiva results in an allergic inflammatory reaction, which in its very nature is a chronic process, with periods of remission and exacerbation corresponding to the fluctuations in the formation of toxin and the exhaustion and recurrence of the local hypersensitivity. Even if the infecting organism is eradicated from the conjunctival sac the tissue hypersensitivity to toxin remains, and fresh infection with the same organism, which must be a common occurrence, is followed by a recurrence of the conjunctivitis. Hypersensitivity to the specific protein of the bacterial bodies of staphylococci is probably unimportant in the etiology of allergic conjunctivitis.

Burky [8] has studied extensively the staphylococcic infections of the conjunctiva. He found that the staphylococci isolated from the normal and pathologic conjunctiva are of three different types. The first is an ordinary nonpathogenic albus type that occurs in the normal eye and that produces no symptoms. The second is a pus-producing pigmented organism found in cases of purulent conjunctivitis, furuncles and pustular blepharitis. The third organism, termed by Burky "Ha," is a hemolytic toxin-producing staphylococcus. This organism produces a strongly potent toxin, 0.1 cc. per kilogram of body weight given intravenously being the lethal dose for an adult rabbit, with death occurring in twenty-four hours. Studies on man and animals by Burky and others have shown that the skin of young persons is not sensitive to this toxin. As human beings and animals grow older, however, and are exposed to constant and repeated infection with staphylococci, a cutaneous sensitivity of greater or lesser degree to this toxin may gradually develop. Likewise, substances develop in the blood which give a positive complement-fixation reaction against an antigen made from this organism. Studies on man and animals have indicated that a positive complement-fixation reaction and a low degree of cutaneous sensitivity to the toxin indicate a comparatively high degree of immunity to the toxin and to staphylococcic infections, while a negative or weak complement-fixation reaction and a high degree of cutaneous sensitivity indicate marked susceptibility to such infections. A person or an experimental animal may be actively protected against the action of this toxin by being given repeated intracutaneous injections of the toxin, desensitization and immunization thus being accomplished, or the subject may be passively protected by the administration of a prepared serum containing the specific staphylococcus antitoxin. Fundamentally important is the fact that the protection resulting from such active or passive immunization is potent not only against the specific toxin but against all staphylococcic infections.

Clinically, there is a large group of patients with recurrent, chronic conjunctivitis and marginal blepharitis in whom this susceptibility to staphylococcus toxin is apparently the specific causative factor. Practically, how may such a condition be detected and treated?

A presumptive diagnosis of allergic conjunctivitis due to hypersensitivity to staphylococcus toxin is made on the criteria of chronic, recurrent nonpurulent conjunctivitis, often associated with the following: folliculosis; marginal blepharitis; reddened, swollen margins of the lids; frequently, slight secondary corneal changes; the elimination of other obvious causes for the conjunctivitis; the isolation of a toxin-

8. Burky, E. L.: Staphylococcus Toxin and Antitoxin, Internat. Clin. **3**:258 (Sept.) 1936.

producing staphylococcus from the conjunctiva; the presence of a high degree of cutaneous sensitivity to staphylococcus toxin, and, usually, a low degree of complement fixation against the staphylococcus antigen. Conjunctival cultures taken after the omission of the use of antiseptics or during exacerbations of the inflammation usually show the toxin-producing organism, although sometimes even when all the other criteria for diagnosis are present the cultures show no staphylococcus on repeated tests, the organism itself presumably having been eradicated but leaving the local hypersensitivity.

The cutaneous sensitivity is determined, first, by the intracutaneous injection of 0.1 cc. of a 1:100 dilution of the toxin and, later, by the injection of a 1:1,000 or a 1:10 dilution, depending on whether the first injection has given a positive or a negative result. A normal person reacts to the 1:100 dilution with an area of erythema approximately from 3 to 4 cm. in diameter. Reactions greater than this or reactions to a higher dilution are regarded as indicating undue hypersensitivity. A strongly positive reaction is sometimes accompanied by a little necrosis at the site of the injection. The complement fixation test is carried out by the usual technic, a 1:8 dilution of the staphylococcus toxin and a 1:8 dilution of the filtrate of broth cultures of a pus-producing staphylococcus being used as antigens and a 1:8 dilution of the filtrate of the nonpathogenic organism being used as a control.

The indicated treatment of such a conjunctivitis is active immunization or desensitization with the staphylococcus toxin. According to the degree of cutaneous sensitivity present, a dilution of the toxin is selected. This is usually 1:100, but for the extremely hypersensitive person with a reaction of more than 8 by 8 cm. a 1:1,000 or a 1:10,000 dilution is used. All the injections are given intracutaneously. The initial dose is 0.1 cc. This dose is given every four days until the local reaction becomes minimal. Usually from four to ten injections are needed for this point to be reached. When a minimal local reaction to the first dilution is reached, the dilution of the toxin is then concentrated ten times, the concentration being increased from 1:1,000 to 1:100 or from 1:100 to 1:10, and 0.1 cc. of this stronger concentration is given until again a minimal reaction is obtained. This is continued until the patient can tolerate 0.1 cc. of pure toxin with a minimal reaction. This is apparently the point of desensitization. During such treatment occasional variations are sometimes seen: A patient may react violently after one injection, while after subsequent injections there is only a minimal reaction. Focal inflammatory conjunctival reactions may come on a few hours after the injection of the toxin and last from twenty-four to thirty-six hours.

In the last few years in the Wilmer Ophthalmological Institute over fifty patients with allergic conjunctivitis due to staphylococcus toxin

have been treated. The results are difficult to tabulate on account of the varying degrees of sensitivity and ocular involvement and the difficulty of achieving and maintaining desensitization. In general the statement can be made that the therapeutic results have been surprisingly good and that this form of treatment has offered in otherwise hopeless and intractable cases a real therapeutic weapon that often gives spectacularly brilliant results.

In several instances passive immunization by means of the injection of an antitoxin serum intramuscularly has been used for patients with staphylococcic septicemia, and in one case of a person with blind cataract who had allergic blepharoconjunctivitis resulting from staphylococcus toxin. In this case one eye had been operated on elsewhere and lost because of postoperative infection. Local treatment to eradicate the staphylococcus from the conjunctiva was totally unavailing. The patient was finally given 20 cc. of a strongly antitoxic rabbit serum intramuscularly and was operated on twelve hours later. He received further daily injections of the antitoxin for five days until signs of a general reaction occurred, after which the treatment was discontinued. Recovery from the operation was uneventful; there was no reaction or infection, although the conjunctival sac constantly contained a virulent toxin-producing staphylococcus.

There is one caution to be emphasized in the use of any foreign antiserum in the treatment of patients with disease of the external part of the eye. A severe reaction may be accompanied by marked edema of the lids. If there is corneal involvement or if such involvement is feared, the sealing of the eye by edema of the lids may be hazardous. For this reason passive immunization is not recommended unless the circumstances are such that there is no other course open.

B, Streptococcus Toxin: There is little actual information on the importance of the toxins of streptococci or other organisms in the production of allergic conjunctivitis. Streptococci produce certain known toxins, hemolysins, leukocytin and scarlatina and erysipelas toxins. Actual allergy to such toxins is possible, and it is conceivable that allergic inflammations of the external part of the eye might result from such sensitization. Scholtz [9] has reported one case of conjunctivitis in which he believed that the condition was clearly due to allergy to streptococcus toxin. However, the whole question of hypersensitivity to streptococci and their toxins is so complicated that it is impossible to speak with any degree of certainty on the subject.

Primarily, there are two types of sensitivity to streptococci and their products. The first is the sensitivity shown following the intra-

9. Scholtz, H. G.: Schwerste stomakake Conjunctivitis, Rhinitis und Bronchitis bei allergischer Diathese, München. med. Wchnschr. **79**:916 (June 3) 1932.

cutaneous injection of suspensions of the actual killed organisms. Such reactions when positive are of the type of delayed tuberculin reactions, coming on after twenty-four hours, and are probably indicative of actual sensitivity to the nucleoprotein of the organisms. The second is the immediate cutaneous sensitivity shown after the intracutaneous injection of filtrates of these organisms, which may indicate sensitivity to specific toxins, to the specific carbohydrate, to the products of bacterial growth or even to substances in the culture mediums. A large percentage of entirely normal persons show positive cutaneous reactions both to suspensions of the bacterial bodies and to the filtrates. Thus, MacKenzie and Hanger [10] expressed the belief that cutaneous hypersensitiveness to such bacterial substances was in general a function of age or an index of normal exposure to infection rather than an index of susceptibility to any specific substance or disease. Numerous other investigators have studied the problem, and there is some evidence that the hypersensitivity is greater and more frequent in certain diseases, notably, rheumatoid arthritis, which is supposedly related to focal infection.

The diagnostic problem is further complicated by the multiplicity of strains of hemolytic streptococci, each of which must be studied as an individual entity. Of the various groups of hemolytic streptococci pathogenic for man, group A contains over thirty strains, group B contains three strains and group F contains four strains. Swift, Lancefield and Goodner [11] stated the belief that different specific strains do not cause different disease conditions but that the reaction to infection with any strain may vary from generalized infections to simple pharyngitis, according to the individual reaction of the infected patient. The magnitude of the task of attempting to detect any specific sensitivity responsible for ocular inflammation can be realized when one considers the high percentage of nonspecific reactions and the large number of strains against which the subject is to be tested.

In actual practice the detection of a streptococcus in the bacterial flora of a patient with chronic conjunctivitis might bring up the question of whether hypersensitivity to the bacterial protein or the products of bacterial growth is responsible for the local inflammation. Since there is no streptococcus toxin or vaccine which gives blanket protection, the only practical method of attacking the problem is the preparation of a killed suspension and of filtrates of cultures of the organism isolated from the patient and testing the patient and controls against such antigens. If the patient shows a reaction to either the killed organism

10. MacKenzie, G. M., and Hanger, F. M., Jr.: Allergic Reactions to Streptococcus Antigens, J. Immunol. **13**:41, 1927.

11. Swift, H. F.; Lancefield, R. C., and Goodner, K.: The Serologic Classification of Hemolytic Streptococci in Relation to Epidemiologic Problems, Am. J. M. Sc. **190**:445, 1935.

or to the filtrates greater than that observed in the controls, the interpretation may be that hypersensitivity to this organism may be concerned in the clinical picture.

As nothing is known of any protective effect of the injection of a streptococcus toxin, the only treatment of supposed allergic conjunctivitis caused by hypersensitivity to a specific streptococcus is vaccine therapy with the killed organisms. Swift [12] and his co-workers have shown that, while intracutaneous injections of killed streptococci tend to sensitize rabbits, intravenous injection of the organism produces an immunity. In the treatment of hypersensitive patients with rheumatoid arthritis Wainwright [13] employed with success the intravenous injection of a salt solution suspension of the heat-killed organisms. An initial dose of 0.5 cc. containing approximately 5,000,000 heat-killed organisms was given. The following doses were determined by the amount of reaction to the first dose. In general, the injections were given at four day intervals, the dose being increased 0.5 cc. at each injection and kept below that by which general symptoms were produced. The patients were treated for periods of from two months to one year. If one must use a streptococcus vaccine, this appears to be the logical procedure.

ALLERGY AND VERNAL CONJUNCTIVITIS

Vernal conjunctivitis is generally believed to be an allergic disturbance. The reasons for this belief are the seasonal occurrence of the attacks, the comparative absence of bacteria in the secretions, the tendency of the disease to attack the young, the specific hypersensitivity and general allergic tendency of the patients and the presence of eosinophils in the conjunctival secretion. While eosinophilia is not pathognomonic of an underlying allergy, it is either dependent on or closely related to the absorption of protein and is usually found in allergic subjects.

The assumption that an underlying allergy is responsible for vernal catarrh is strengthened by the experimental demonstration that the conjunctiva is susceptible of specific sensitization and by the histologic study of the follicles on the bulbar and palpebral conjunctiva. The follicle which appears on the eye near the limbus has the general histologic picture of a phlyctenule, which has rather definitely been proved to be an allergic manifestation. The second type of follicle, which appears on the palpebral conjunctiva, consists of papillary swelling

12. Swift, H. F.: The Pathogenesis of Rheumatic Fever, J. Exper. Med. **39**:497, 1924.

13. Wainwright, C. W.: Treatment of Chronic Rheumatoid Arthritis with Streptococcus Vaccine on the Basis of Skin Sensitivity, J. A. M. A. **103**:1357 (Nov. 3) 1934.

associated with proliferation of connective tissue, with infiltration by lymphocytes, plasma cells and eosinophils. This reaction is somewhat comparable to that seen in the bronchial walls in cases of asthma and in the skin in cases of eczema and has been spoken of as an allergic reaction characterized by persistent granulation.

In 1933 LaGrange and Delthil [14] published a short monograph on conjunctivitis and vernal catarrh and in the last three years have published other papers [15] on the same subject. These authors stated that they definitely regard vernal conjunctivitis as an allergic disease of the pseudofollicular type of conjunctival allergy. Their conclusion is based principally on clinical observation and study. They accept the specific sensitization of the conjunctiva as a fact proved by experiments. The classic allergic syndrome of vernal conjunctivitis is: (1) the clinical picture, the recurrences and the associated itching; (2) the climatic and seasonal incidence; (3) the frequent association of vernal conjunctivitis with other allergic conditions, such as asthma, hay fever, urticaria and angioneurotic edema; (4) the absence of bacteria and inclusion bodies and the presence of eosinophils in the conjunctival secretions; (5) the cutaneous sensitivity and the positive Prausnitz-Küstner reaction to the specific allergen, shown by the patient; (6) the reaction of the affected conjunctiva, first, to epinephrine and, second, to the specific allergen; (7) the frequent association of endocrine disturbances and an imbalance of the vagosympathetic system.

LaGrange and Delthil [14] stated that they are firmly of the opinion that other factors influence the allergic diathesis of the affected persons. These factors are heredity and endocrine disturbances. These authors believe that disorders of the endocrine glands induce a secondary imbalance of the vagosympathetic system and that this predisposes to sensitization of the tissues and the resultant allergic reactions. They believe that the conjunctival localization of the sensitivity and allergic reaction in vernal conjunctivitis is only another manifestation of the elective localization of cutaneous allergy and that possibly the direct exposure of the conjunctiva to direct sensitization may be responsible for this.

In support of these views these authors report in detail a large number of clinical cases of allergic and vernal conjunctivitis illustrating the various points emphasized in their allergic syndrome, especially endocrine disorders, affecting principally the gonads, alterations in the oculocardiac reflex, and certain rather startling results obtained by organotherapy with various endocrine preparations. Especially interest-

14. LaGrange, H., and Delthil, S.: Les conjonctivites de nature anaphylactique, Paris, Gaston Doin & Cie, 1932.

15. LaGrange and Delthil.[2] LaGrange, H.: Le rôle de l'allergie dans certaines conjonctivites, Bull. Soc. d'opht. de Paris, April 1935, p. 230.

ing is LaGrange's last observation in 1935, which indicates that patients with vernal catarrh show evidences of the vascular shock reaction termed by Widal the *phenomènes colloidoclasiques,* which is seen constantly in cases of experimental anaphylactic shock.

This is the evidence so far amassed that vernal conjunctivitis is an allergic disease—the clinical picture, the absence of bacteria, the seasonal occurrence, the experimental demonstration that the conjunctiva is susceptible of specific sensitization, the evidence that patients with the disease have a much higher percentage of associated allergy than do normal patients, the demonstration of a pathologic hypersensitivity to allergens in the greater percentage of such patients and the pathologic picture of the diseased conjunctiva.

From the point of view of the clinician, how must such an assumption influence one's approach to the study and treatment of this disease? The problem is little different from that already outlined for other forms of allergic conjunctivitis. The essential thing is to find the specific allergen or allergens to which the patient is hypersensitive and endeavor, first, to isolate the patient from these substances and, second, since vernal conjunctivitis is a recurrent, chronic disease, to achieve and maintain desensitization. Such procedures are no contraindication to other routine therapy, the use of astringent collyria, treatment with radium or even organotherapy. Personally, I believe that the present knowledge of endocrinopathies and endocrine therapy has not yet progressed to the point where organotherapy is an indicated procedure except when used in a very limited degree.

ALLERGY AND FOCAL INFECTION

Recent experimental work has indicated that certain types of recurrent uveitis and iritis may be allergic reactions dependent on sensitization and intoxication of the uveal tissue by bacterial derivatives. In 1933 I [16] summed up the evidence in favor of this proposition. This idea was primarily suggested by the frequency with which sterile cultures were obtained from the iris and aqueous in cases of acute iritis and by the flare-ups in the ocular inflammation which frequently followed the subcutaneous administration of bacterial vaccines. Experimentally this hypothesis found strong confirmation in the work of Swift and Derick,[17] Schultz and Swift,[18] Julianelle,[19] Seegal and

16. Woods, Alan C.: Allergy and Immunity in Ophthalmology, Baltimore, Johns Hopkins Press, 1933.

17. Swift, H. F., and Derick, C. L.: Hyperergic Tissue Response to Non-Hemolytic Streptococci, Proc. Soc. Exper. Biol. & Med. **25**:222, 1927-1928.

18. Schultz, M. P., and Swift, H. F.: Reaction of Rabbits to Streptococci: Comparative Sensitizing Effect of Intracutaneous and Intravenous Inocula in Minute Doses, J. Exper. Med. **55**:591, 1932.

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Seegal [20] and others. These investigators had shown that repeated intracutaneous injections of living streptococci or the absorption of bacterial products from an agar focus implant produced in the experimental animal a definite hypersensitivity of the ocular tissues, and later contact of the sensitized eye with the specific bacteria or bacterial products resulted in ocular inflammation. This was termed the ophthalmic reaction. Since 1933 the experimental foundation for this theory has been still further strengthened. Seegal and Seegal and Khorazo [21] showed that if eyes sensitized by the direct injection of a specific protein in the anterior chamber were allowed to rest until all traces of specific protein had disappeared from the anterior chamber and were then activated by an intravenous injection, traces of the specific antigen again appeared in the anterior chamber. This finding gave an explanation for the resensitization of eyes after the primary reaction and readily explains why recurrent attacks of inflammation may take place. Seegal and Seegal [22] also showed that if the eyes of experimental animals were subjected to some nonspecific inflammation or insult at the time a foreign protein was circulating in the blood stream, the circulating foreign protein was absorbed directly into the eye, and sensitization of the eye resulted. Julianelle, Morris and Harrison [23] found certain cases of vascularization of the cornea in which the condition was an allergic phenomenon. Eyes sensitized by repeated intracutaneous and subconjunctival injections and later traumatized and exposed to the absorption of the specific antigens showed corneal vascularization. This these authors obtained with certain bacterial antigens, with egg albumin and with the purified nucleoprotein of various organisms. Such vascularization was likewise obtained by the repeated

19. Julianelle, L. A.: Reactions of Rabbits to Intracutaneous Injections of Pneumococci and Their Products: V. The Development of Eye Reactivity to Derivatives of Pneumococci, J. Exper. Med. **51**:633, 1930; VI. Hypersensitiveness to Pneumoccoci and Their Products, ibid. **51**:643, 1930.

20. Seegal, D., and Seegal, B. C.: Local Organ Hypersensitiveness: I. Experimental Production in the Rabbit Eye, Proc. Soc. Exper. Biol. & Med. **27**:390, 1930.

21. Seegal, B. C.; Seegal, D., and Khorazo, D.: Local Organ Hypersensitiveness: V. The Fate of Antigen and the Appearance of Antibodies During the Development of Hypersensitiveness in the Rabbit Eye, J. Immunol. **25**:207, 1933.

22. Seegal, B. C., and Seegal, D.: Local Organ Hypersensitiveness: VI. An Indirect Method for Its Production in the Rabbit Eye, J. Immunol. **25**:221, 1933.

23. Julianelle, L. A.; Morris, M. C., and Harrison, R. W.: Studies on Vascularization of the Cornea: I. Sensitization of Cornea of Rabbits to Bacteria, J. Immunol. **26**:267 (April) 1934; II. Sensitization of Cornea of Rabbits to Proteins, ibid. **26**:281 (April) 1934. Julianelle, L. A.; Harrison, R. W., and Morris, M. C.: III. Sensitization of Cornea of Monkeys, ibid. **26**:295 (April) 1934. Julianelle, L. A.; Morris, M. C., and Harrison, R. W.: IV. Question of Passive Corneal Hypersensitiveness, ibid. **26**:303 (April) 1934.

application of living cultures to the lightly scarified cornea, becoming apparent after the ninth exposure. This allergic reaction appeared as a local manifestation and had no relation to the general antibody content of the blood serum or to the heightened reactivity of the skin to the specific allergens. In 1934 Brown [24] repeated the work of Swift and Derick and their co-workers. His experiments indicated that the ocular sensitivity resulting from infected agar implants might occur as early as the first to the third day. Further, eyes directly sensitized by killed streptococci could be activated by remote infected agar implants, indicating that bacterial products diffusing out from a chronic focus of infection could produce inflammatory intra-ocular reactions in sensitized intra-ocular tissues. A further step forward was made by experiments of MacLean [25] in the Wilmer Ophthalmological Institute. MacLean confirmed the results of the earlier work of Swift and Derick and their co-workers on the ophthalmic reaction and succeeded in producing a transient inflammatory uveal reaction in the untraumatized eye through intracutaneous sensitization and intravenous intoxication with living streptococci. Brown [26] recently showed that multiple sensitization of eyes could be obtained experimentally by the injection of different allergens, both bacterial and protein. He further showed that the injection of an excessive dose of one of these allergens resulted in the subsequent inhibition of intoxication by other allergens. If typhoid vaccine was used as an "interfering allergen" and the antibody content of the aqueous was artificially increased, the intoxicating effects of other allergens was inhibited. This offers a possible new explanation for the effect of nonspecific protein therapy—that the mobilization of nonspecific antibodies in the aqueous inhibits the intoxicating effects of other allergens to which the eye may be sensitive.

A number of observers, notably, Julianelle [27] and Seegal, Heidelberger and Jost [28] have endeavored to determine to which portion of the bacterial antigen mosaic the ocular sensitivity was due. Julianelle showed that the sensitivity resulting from the intracutaneous injections was apparently due to the nucleoprotein of the bacterial body, and Seegal and Heidelberger, working on the formation of precipitins with

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24. Brown, A. L.: Chronic Uveitis: Bacteriologic and Immunologic Considerations, Arch. Ophth. **12**:730 (Nov.) 1934.

25. MacLean, A. L.: Experimental Iritis: The Ocular Reactions in Rabbits Sensitized to Streptococcus Viridans, Tr. Am. Ophth. Soc., 1936, to be published.

26. Brown, A. L.: Tr. Am. Ophth. Soc. **33**:435, 1935.

27. Julianelle, L. A.: Reactions of Rabbits to Intracutaneous Injections of Pneumococci and Their Products, J. Exper. Med. **51**:441, 1930.

28. Seegal, D.; Heidelberger, M., and Jost, E. L.: The Formation of Precipitin for the Group A Specific Carbohydrate of Streptococcus Hemolyticus in Rabbits Injected Intravenously and Subcutaneously. J. Immunol. **27**:211. 1934.

the specific carbohydrate of Streptococcus haemolyticus, confirmed the results of Julianelle's work, their experiments indicating that the sensitivity was chiefly due to the nucleoprotein fraction and not to the specific carbohydrate. In 1929 Tillet and Francis,[29] working with patients with lobar pneumonia, showed that the immediate edematous reactions of the skin to pneumococci were due to the specific carbohydrate, while the delayed tuberculin type of reaction was due to the nucleoprotein of the pneumococcus.

Berens and his co-workers [30] studied from the clinical point of view the cutaneous reactions and the agglutinin titer of patients with ocular diseases against various organisms isolated from the nose, infected teeth and tonsils of these patients. They expressed the belief that such serobacteriologic studies give information as to the identity of the organism responsible for the ocular lesion and that such reactions are of decided value to the ophthalmologist studying diseases of the eye due to focal infection and likewise might indicate the specific bacteria from which vaccines for therapeutic use should be prepared. Benedict [31] has called attention to the relationship between infection in the female pelvis and certain recurrent ocular diseases and to the beneficial effects obtained with autogenous vaccines. There are other reports, too numerous to mention, on the use of autogenous vaccines isolated from foci of infection in the treatment of recurrent ocular disease.

Thus it is evident that a rather substantial experimental background has been built up for the hypothesis that recurrent iritis or recurrent uveitis may be an actual allergic manifestation due to sensitization and intoxication from bacterial allergens. Confronted with this experimental evidence that allergy may be concerned in chronic, recurrent uveitis and with the clinical evidence of heightened cutaneous reactivity to certain bacteria harbored in suspected foci of infection, what should be the position of the clinical ophthalmologist on the problem? Ophthalmologists are constantly confronted with the suggestion that the skin of the patient be tested against all organisms isolated from any focus of infection or even from the gastro-intestinal tract and that the organisms to which it may react be assembled into an autogenous vaccine for therapeutic use. Such vaccine therapy, based solely on cutaneous reactivity to bacteria, in the present state of knowledge, is to my mind unjustifiable and scientifically indefensible. In the normal course of

29. Tillet, W. S., and Francis, T.: Cutaneous Reactions to the Polysaccharides and Proteins of Pneumococcus, J. Exper. Med. **50**:687, 1929.

30. Berens, C.; Connolly, P. T., and Chapman, G. H.: Focal Infection in Diseases of the Eye: I. Report of Certain Laboratory Examinations, Am. J. Ophth. **17**:1094, 1934.

31. Benedict, W. L.: The Relation of Infections of the Pelvic Organs and Diseases of the Eye, Am. J. Ophth. **16**:665, 1933.

life any average human being is bound to become hypersensitive and show a cutaneous reactivity to a great host of common bacteria to which he is constantly exposed. All studies such as those of Derick and Fulton,[32] MacKenzie and Hanger,[10] Birkhaug [33] and numerous other investigators have shown that the greater percentage not only of diseased persons but of normal persons have a cutaneous sensitivity to common organisms, such as streptococci and their derivatives. If one accepts such cutaneous reactivity as a criterion for vaccine therapy, there is no disease in the whole gamut of pathologic conditions of man which should not be so treated. The patient has no chance of escape. Further, it is not clearly known whether the vaccine should be prepared from the bacterial bodies or from the filtrates. In the case of staphylococci, as has already been pointed out, all the evidence indicates that the maximum protective effect is obtained by a properly prepared filtrate of toxin, while in the case of streptococci the present indications are for the use of a vaccine prepared from the bacterial bodies. To determine the proper preparation of vaccine each suspected organism must be studied separately; otherwise one is guilty of the rankest kind of shotgun therapy. In the present state of knowledge there appears to be little justification for the use of a vaccine prepared from the intestinal flora. In the case of organisms isolated from a focus of infection, the only indication for the use of a vaccine would be, first, that there is some reason because of the nature of the illness and the exclusion of other causal factors to suspect one individual organism and, second, that the affected person shows a far more intense cutaneous reactivity to this organism than would normally be expected or than is shown by normal controls. Only with these criteria, I believe, is the use of a vaccine justified in cases of recurrent uveitis, and then certainly not until the first duty—the eradication or treatment of the primary focus of infection—has been accomplished. In short, while there is much experimental evidence to indicate that certain cases of recurrent uveitis may be due to bacterial allergy from a focus of infection, such a proposition is far from being proved, and with the present limited knowledge there is little justification for the current promiscuous use of vaccine therapy in cases of recurrent uveitis.

CONCLUSIONS

Allergic conjunctivitis may appear as: (1) sudden transitory conjunctivitis, characterized by edema, chemosis and conjunctival congestion and injection; (2) chronic blepharoconjunctivitis with a tendency

32. Derick, C. L., and Fulton, M. N.: Skin Reactions of Patients and Normal Individuals to Protein Extracts of Streptococci, J. Clin. Investigation **10**:121, 1931.

33. Birkhaug, K. E.: Rheumatic Fever: III. Skin Hypersensitiveness of Patients with Rheumatic Fever and Chronic Arthritides to Filtrates, Autolysates and Bacterial Suspensions of Streptococci, J. Infect. Dis. **44**:363 (May) 1929.

to eczema of the lids, or (3) chronic, recurrent conjunctivitis, often complicated by folliculosis and blepharitis.

Such conjunctivitides may be due to pollens, food, animal dusts, inhalants or bacterial toxins and proteins. The diagnosis is made on the basis of demonstration of a specific cutaneous hypersensitivity and may be confirmed by an ophthalmic test. Treatment consists of isolation of the patient from the offending allergen and specific desensitization.

The present evidence indicates that vernal catarrh is an allergic disturbance.

While there is much experimental evidence indicating that recurrent iritis may sometimes be an allergic reaction due to bacterial hypersensitivity, this has not been proved clinically, and there is little justification for vaccine therapy in cases of this condition.

TRACHOMATOUS KERATITIS

A BIOMICROSCOPIC STUDY OF TWO HUNDRED AND EIGHTY INDIAN SCHOOL CHILDREN

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Prior to the advent of the biomicroscope the pannus of trachoma was generally believed to be a frequent but not invariable complication of the disease, occurring usually months or years after the onset. The slit lamp studies of Dusseldorp,[1] Danilevskij,[2] Wilson,[3] Cuénod and Nataf,[4] Gallemaerts,[5] Busacca,[6] Horváth,[7] Morax,[8] Morax and Petit,[9] Howard[10] and others have indicated that pannus is not a complication of trachoma but an integral part of the disease, appearing in its earliest stages. Of particular interest have been the reports of Cuénod and Nataf from Tunis, Wilson from Egypt, and Busacca from Brazil.

Cuénod and Nataf found biomicroscopic signs of pannus in children with pure trachoma at a time when gross examination revealed no changes. Wilson, considering only the vascular changes of pannus, found extension of capillary loops into the cornea invariably in Egyptian trachoma. In patients followed from the onset he observed that the first changes of pannus usually appeared simultaneously with the

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1. Dusseldorp: Tracoma, Thesis, National University, Buenos Aires, 1927; cited by Cuénod and Nataf.[4]

2. Danilevskij, I.: Ueber die Bedeutung der Spaltlampe zur Diagnostik des Trachoms, Zentralbl. f. Ophth. **24**:641, 1930.

3. Wilson, R. P.: A Short Slit-Lamp Study on the Corneal Vessels in Egyptian Trachoma, Folia ophth. orient. **1**:52, 1932.

4. Cuénod, A., and Nataf, R.: Biomicroscopie de la conjonctive, Paris, Masson & Cie, 1934, p. 90.

5. Gallemaerts: Trachome et coloration vitale, Ann. d'ocul. **161**:815, 1924; Examen microscopique des affections de la cornée au moyen de la lampe à fente, Bull. et mém. Soc. franç. d'opht., supp., May 1926.

6. Busacca, A.: La frequenza della complicazioni corneali nel trachoma de dotta dallo esame de cento casi, Rev. internat. du trachome **10**:57, 1933; Recherches sur l'étiologie du trachome et sur la localization du trachome a la cornée, Rev. biol. e hyg. **5**:88, 1934; Die trachomatöse avaskuläre Keratitis, Klin. Monatsbl. f. Augenh. **94**:202, 1935.

7. Horváth, B.: Hornhaut bei Trachom, Klin. Monatsbl. f. Augenh. **72**:243, 1924.

8. Morax, V.: Complications cornéenes du trachome, Rev. internat. du trachome **6**:90, 1929.

9. Morax, V., and Petit, J.: Le trachome, Paris, Jean Morax, 1929.

10. Howard, H. J.: The Diagnosis of Trachoma, Am. J. Ophth. **16**:132, 1933.

conjunctival lesions. In cases of follicular and catarrhal conjunctivitis he found no vascular changes. Busacca considered the trachomatous cornea in detail, controlling his slit lamp studies with microscopic examination of material removed for biopsy. This control enabled him to correct certain errors made by previous investigators as to the vascularization of the normal limbus, the nature of the so-called palisades and the occurrence of trachomatous follicles in the cornea. He found avascular keratitis in all the cases of active trachoma which he observed and noted that it occurred before vascularization in patients followed from the onset.

A previous report [11] recorded the occurrence of pannus in a small series of patients with trachoma in the white population of Iowa and differentiated trachomatous pannus from the pannus associated with other diseases. It was concluded that biomicroscopic examination of the region of the upper limbus was of particular value in distinguishing cases of early trachoma from those of inclusion conjunctivitis in which pannus does not occur. This is the disease most commonly confused with trachoma in this country.

In view of the divergence of opinion among physicians of the Indian Medical Service and visiting ophthalmologists as to the frequency of pannus among trachomatous Indian children, it seemed desirable to undertake a slit lamp study of a representative series of Indian patients. Permission was received from the Office of Indian Affairs to examine infected children at the school for children with trachoma, Fort Apache, Ariz., and normal children from the school at Whiteriver, Ariz. Dr. F. I. Proctor, consultant on trachoma, and Dr. James C. Hancock, special physician, both of the Indian Medical Service, gave personal assistance in these studies, and Dr. Polk Richards, director of trachoma activities, gave help and advice.

MATERIAL AND METHOD OF STUDY

Two hundred and forty-eight Indian children varying in age from 6 to 19 years were available for study. All had been placed in the school because of trachoma or suspected trachoma and were receiving appropriate therapy. In addition, 32 children from the Whiteriver school, selected because of normal conjunctivae, were observed as controls.

Except for corneal scars suggestive of previous phlyctenular keratitis in 3 children, no evidence was found of other corneal disease capable of producing pannus. According to Dr. Richards, phlyctenular keratoconjunctivitis was formerly common but decreased in frequency after increased appropriations for food in the boarding-schools. Only a single case of active phlyctenulosis was observed in the two schools during a thirty day period of observation.

Routine examination at a magnification of 22 diameters was made of the entire cornea of each child; special attention was given to the region of the upper limbus.

11. Thygeson, P.: Biomicroscopy of the Limbus Corneae in Trachoma and Other Conjunctival Diseases, Am. J. Ophth. **17**:787, 1934.

REPORT OF OBSERVATIONS

Characteristics of Trachoma in the Indians.—Trachoma as observed in the Apache Indians appeared to differ in no essential way from trachoma in the white population. The lesions presented by the children of this series could be classified readily according to MacCallan's [12] classification; all stages of the disease occurred. While symblepharon, severe scarring and gross pannus were observed in the children, the complications of trichiasis and entropion were seen only in the adult population. Examination of smears of secretion and epithelial scrapings indicated that the incidence of secondary bacterial infection was higher than that in trachoma in the white population of Iowa. The most common bacteria found were Haemophilus lacunatus (Morax), Haemophilus influenzae, Diplococcus pneumoniae and Staphylococcus. Halberstaedter-Prowazek inclusion bodies were present in a considerable number of cases.

The Normal Limbus.—The limbus of the Indian children, except for the presence of considerable pigment in the epithelium, showed no peculiarities not found in white persons. In general, palisade formation was inconspicuous. As in the previous study, the semiopaque border of the limbus as viewed by focal illumination was found to be a satisfactory landmark by which to judge vascularization. In the 32 normal children the end capillary loops of the limbus extended to, or slightly beyond, this border.

The Trachomatous Limbus and Cornea.—The changes of trachomatous pannus were observed in all but 8 of the 212 children whose condition was diagnosed as trachoma on the basis of the conjunctival lesions alone and in 16 of the 36 whose condition was classed as "doubtful trachoma." Seven distinct lesions were observed: (1) extension of vessels into the cornea; (2) limbic follicles; (3) Herbert's peripheral pits; (4) diffuse subepithelial infiltrates; (5) localized subepithelial infiltrates; (6) minute punctate epithelial lesions, stainable with fluorescein; (7) corneal scars. So-called pustules of trachoma, which, according to Busacca, are collections of polymorphonuclear leukocytes, were not observed in the children but were seen in a single adult Indian with acute exacerbation of old trachoma. They have been observed not uncommonly in cases of trachoma in the white population.

Vascularization.—There appeared to be an extension of preexisting limbic loops into the cornea rather than formation of new blood vessels. The degree of penetration varied from about 1 mm. at the upper limbus to complete vascularization of the cornea. In mild pannus only the upper two fifths of the cornea was involved, but if the pannus

12. MacCallan, A. F.: Trachoma and Its Complications in Egypt, London, Cambridge University Press, 1913.

was at all severe there was penetration into the cornea over its entire circumference, always more extensive above.

Although pannus is usually classified as incipient, active or cicatricial, it seemed desirable for the purposes of comparison to classify it according to the extent of penetration of the vessels. Thus, four degrees of pannus were recognized, as follows: In first degree pannus the vessels extended approximately 1 mm. into the cornea at the upper limbus (fig. 1 *A*); in second degree pannus, approximately halfway to the pupillary area (fig. 1 *B*); in third degree pannus, approximately to the edge of the pupillary area (fig. 1 *C*), and in fourth degree pannus, over the entire cornea (fig. 1 *D*). The caliber of the vessels appeared to vary directly with the activity of the pannus: In cicatricial or healed pannus the vessels were small and in many instances contained no blood, whereas in pannus of high activity with circumcorneal congestion the vessels were large and dilated.

Limbic Follicles.—Limbic follicles (fig. 1 *D*), varying in number from three to thirteen, were present in 12 of the 204 patients with pannus. They were grayish, translucent globular masses, avascular except for occasional fine capillaries ramifying on their surfaces. They were arranged usually in a single row, concentric with the cornea, with the largest in the center, but were occasionally in double rows. In this series they were not seen below the horizontal meridian. They occurred most frequently in third degree pannus but were also present in second degree pannus and fourth degree pannus. They were never seen in the cornea itself. The description of trachomatous follicles in the corneal tissue by some observers has probably been the result of confusion of trachomatous pustules with trachomatous follicles. According to the histologic studies of Busacca,[6] the pustules are made up almost entirely of neutrophil leukocytes and are a manifestation of acute corneal trachoma. The rupture of the epithelium over the pustules, with the formation of shallow ulcers, is therefore in no way comparable to the rupture of trachomatous follicles in the conjunctiva.

Herbert's Peripheral Pits.—Typical pits, the remains of limbic follicles which have undergone absorption, were observed in 11 of the 204 patients with pannus. Like the follicles, they were usually bilateral but in a few instances were seen in only one eye. They appeared as round or oval semitransparent areas (fig. 1 *C*) in the white opacity of the limbus. They were usually arranged in a single row, with the largest in the center. Unlike the limbic follicles, which bulged forward, they appeared as flat or depressed areas. The term pit, however, would seem to be misleading since there is no actual depression. When not marked they gave the limbus a grossly fenestrated or arcade-like appearance.

Diffuse Subepithelial Infiltrates.—Diffuse infiltrates were seen frequently, especially in the region of new vascularization. In some instances this infiltration was so dense as to render determination of the semiopaque border of the limbus difficult.

Localized Subepithelial Infiltrates.—Localized infiltrates were especially well seen in the vessel-free parts of the cornea. They varied in size and number but were usually irregular in shape, sometimes having pseudopodia-like processes. In some cases they could be observed undergoing apparent replacement by scar tissue.

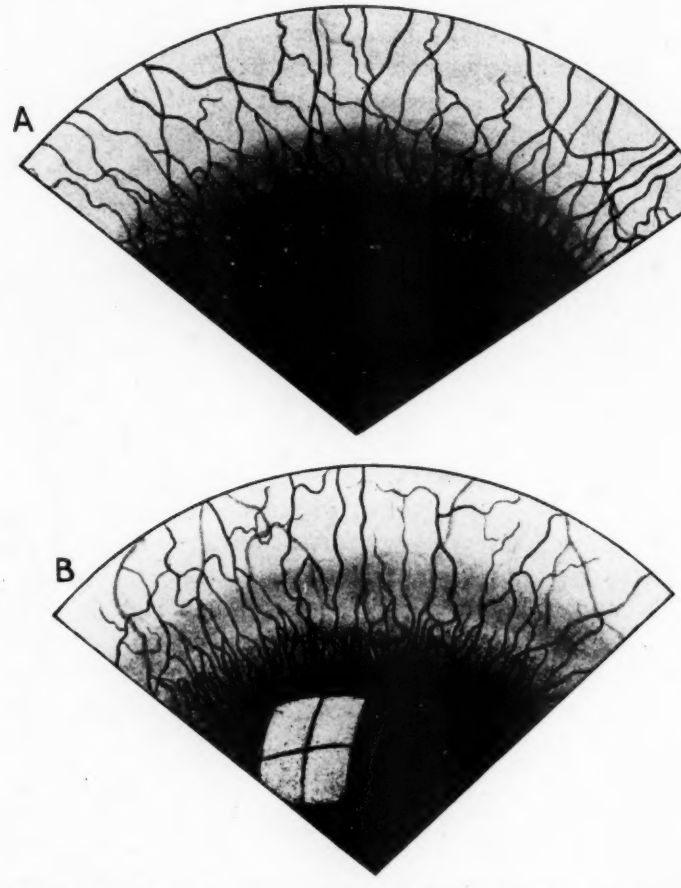

Fig. 1.—*A*, first degree pannus in an Indian child with trachoma of stage I (incipient trachoma). Capillary loops extend into the cornea well beyond the normal border of the limbus. Beyond the vessels are spotty infiltrates. The normal sheen of the cornea is reduced by edema of the epithelium and by punctate epithelial lesions which stain with fluorescein. *B*, second degree pannus in an Indian child with trachoma of stage III (cicatricial trachoma). The vessels extend about halfway to the pupillary area. The normal border of the limbus is somewhat obscured, owing to infiltrates. There is definite keratitis beyond the vessels, evidenced by infiltrates, by edema of the epithelium and superficial layers of the corneal stroma and by punctate epithelial lesions.

Epithelial Lesions.—Almost every patient showed the minute punctate epithelial lesions (fig. 2) which stain with fluorescein. These varied greatly in extent, in general being in proportion to the activity of the pannus as judged by infiltration, dilatation of the vessels and circumcorneal congestion. All the vessel-free parts of the cornea were involved in one or another of the cases, but the region of the pupil and the area just above it were most commonly affected.

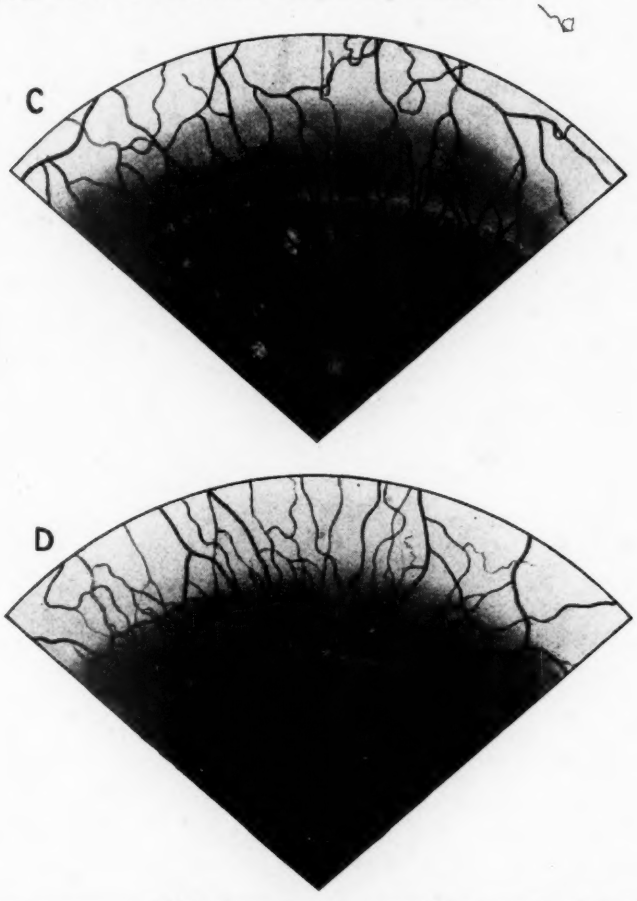

Fig. 1.—*C* represents third degree pannus in a child who suffered from trachoma of stage III. The vessels extend to the pupillary area and are of coarse mesh. In addition to active infiltrates, epithelial lesions and corneal edema, there are a number of round scars, probably evidence of healed ulcers. At the limbus are Herbert's pits, the remains of previously existing limbic follicles. *D*, fourth degree pannus in association with trachoma of stage III. The entire cornea is vascularized. The continued activity of the corneal disease is evidenced by dilated vessels, infiltrates and limbic follicles.

Corneal Scars.—Scars resulting from previous ulceration were seen in only a small number of cases. In some instances of extensive pannus cicatricial tissue had replaced subepithelial infiltrates.

Correlation of Extent of Pannus with Stage of Trachoma.—In table 1 the degree of pannus is correlated with the stage of trachoma. In trachoma of stage I, as would be expected, first degree pannus was twice as frequent as second degree pannus. There was one case of third degree pannus, showing that severe pannus can occur prior to the onset of conjunctival scarring and relatively early in the disease. In trachoma of stage II*a* first degree pannus and second degree pannus were the rule, but there were 2 cases of third degree pannus. In trachoma of stage II*b*, first degree pannus and second degree pannus were about equally common. In trachoma of stage III all degrees of pannus were present, 29 of a total of 134 patients having the extensive vascularization of third degree pannus. There were only 2 cases in which the cornea was completely vascularized. It is interesting that in 8 cases [13] of healed trachoma, pannus was only of the first or the second degree.

Fig. 2.—Minute punctate epithelial lesions, which stain with fluorescein, in the vessel-free part of the cornea in a patient with extremely active pannus.

TABLE 1.—*Extent of Pannus and Stage of Trachoma*

Stage of Trachoma	Extent of Pannus*				Total
	First Degree	Second Degree	Third Degree	Fourth Degree	
I	7	4	1	0	13
II*a*	18	12	2	0	32
II*b*	12	11	0	0	23
III	57	46	29	2	134
IV	1	1	0	0	2
					204

* See figures 1A to D. When the degree of pannus differed in the two eyes, the more advanced degree was recorded.

Correlation of Extent of Pannus with Age.—As indicated in table 2, there was no sharp correlation between the age of the child and

13. Six of these cases were instances of healed trachoma observed in the Whiteriver school.

the degree of pannus. In general, however, the relative frequency of second degree pannus and third degree pannus increased with age; complete vascularization (fourth degree pannus) was observed in only 2 patients, both aged 14 years.

Pannus in Doubtful Trachoma.—Pannus was present in either the first or the second degree in 16 of 36 children with a condition classified as doubtful trachoma on the basis of conjunctival examination.

None of the patients had scarring or characteristic lesions of the upper tarsal conjunctivae, and it would have been impossible by gross examination alone to make an indisputable diagnosis of trachoma. The occurrence of follicles at the upper border of the tarsus and in the upper fornix, however, was suggestive of trachoma, and in the presence of the vascular and infiltrative changes of early pannus was sufficient to establish a diagnosis.

TABLE 2.—*Type of Pannus and Age of Child*

	Extent of Pannus*				
Age, Years	First Degree	Second Degree	Third Degree	Fourth Degree	Total
6	4	1	0	0	5
7	4	3	4	0	11
8	16	9	0	0	25
9	10	8	2	0	20
10	11	5	2	0	18
11	10	6	1	0	17
12	6	3	4	0	13
13	9	12	5	0	26
14	8	7	4	2	21
15	8	7	4	0	19
16	5	9	1	0	15
17	4	2	2	0	8
18	4	1	0	0	5
19	1	0	0	0	1
					204

* See figures 1A to D.

Significance of Trachoma Without Pannus.—In 7 of the 8 cases in which the condition was diagnosed as trachoma but in which no pannus could be discovered the changes were those of stage 3 and showed little, if any, activity. In view of the fact that many of the children had been previously subjected to grattage it is not impossible that the scars on the basis of which the diagnosis of trachoma was made were mechanical and not trachomatous. The eighth patient showed no scars and, except for the absence of involvement of the upper tarsal conjunctiva, had the follicular hypertrophy of stage II*a*. The predominance of involvement of the lower lid was suggestive of inclusion conjunctivitis.

In none of the 8 cases was there avascular keratitis.

COMMENT

The observations just reported indicate that pannus occurs early in the course of trachoma in Indian children and that slit lamp examina-

tion of the limbus and cornea is of diagnostic value in doubtful cases. It is recommended, therefore, that biomicroscopic examination of the limbus and cornea be made as a routine in the examination of patients suspected of having trachoma. It is believed that the consistent use of the slit lamp will simplify the differentiation of early trachoma from follicular and other types of conjunctivitis.

There is no doubt that pannus occurs frequently in association with trachoma, but whether or not it invariably accompanies the disease is not yet satisfactorily established. Slit lamp examination of patients with trachoma in the white population during the past four years has always shown pannus, although the changes were mild in some instances. In several cases, in spite of pronounced conjunctival lesions, gross pannus never developed, although permanent biomicroscopic signs of previous disease persisted at the limbus even after healing. At the other extreme was a case in which pannus was grossly visible six weeks after the onset of the symptoms and in which, in spite of treatment, vessels reached the pupillary area within twelve months. The constancy of corneal involvement in trachoma of the white population favors the view that it always occurs in association with the disease and that the 8 children with normal corneas in the series of Indian patients were therefore not trachomatous.

SUMMARY AND CONCLUSIONS

1. The vascular and infiltrative changes characteristic of trachomatous pannus were observed on biomicroscopic examination in 203 of 211 Indian children with a condition diagnosed as trachoma on the basis of the conjunctival findings alone, a percentage of 96.2 per cent.

2. Seven of the 8 children without pannus had scarred conjunctivae with minimal inflammatory changes. It is possible that in these cases the condition was not trachoma but follicular conjunctivitis which had been subjected to grattage at some previous time. The eighth child had changes suggestive of inclusion conjunctivitis.

3. The important biomicroscopic signs of trachomatous disease of the cornea are briefly discussed.

4. Limbic follicles or their remains, Herbert's peripheral pits, were found in approximately 20 per cent of the patients with pannus.

5. Pannus was seen in 16 of 36 children with a condition classed as doubtful trachoma.

6. Pannus was not observed in 32 children with normal conjunctivae. The cicatricial remains of pannus were present in 8 children with healed trachoma.

7. This study supports the conclusion that the first signs of trachomatous pannus appear early in the disease.

PHYSICS OF DIATHERMIC COAGULATION IN THE EYE

EXPERIMENTAL STUDIES AND SOME PRACTICAL NOTES ON THE OPERATION

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The best known method for healing retinal detachment is diathermic coagulation. Nearly every ophthalmologist has his special method for carrying out diathermic operations. All these methods lack a reliable control of the dosage, because the physical basis of diathermic coagulation has been neglected.

My co-worker, Mr. Heinrich Kalmus, and I have found a convenient method of observing the process of coagulation in the measurement of the electrical resistance of the eye. From the variations of the resistance reliable conclusions may be drawn as to the state of coagulation.

In this article adequate test methods and the results of experiments are described. On the basis of these experiments the relative values of the different methods of operation are considered. The knowledge of electrical resistance furnishes a convenient and accurate method to indicate the proper dosage of diathermic irritation in the human eye.

SURVEY OF THE PREVIOUS LITERATURE

The widespread treatment for healing retinal detachment is diathermic coagulation. The methods of operation, however, as suggested by various authors are quite different. Some prefer surface coagulation; others use micropuncture or a combination of the two methods.

It is sufficient to mention one exponent of each of these methods to show how different the opinions are. Coppez [1] maintained that surface coagulation leads to adhesive choroiditis, which is the principal condition of healing, whereas the use of pins may cause grave infiltration and damage of the retina. Vogt,[2] on the contrary, expressed the belief that surface coagulation has the disadvantage, common to all surface methods, of leading to diffuse chorioretinitis, thereby damaging larger retinal parts than is necessary. The atrophy of the retina hinders

From the Department of Ophthalmology, the Jewish Hospital, Budapest, 1935.

1. Coppez, Léon: Arch. internat. de méd. expér. **9**:177, 1934.
2. Vogt, A.: Arch. f. Ophth. **133**:26, 1935.

ophthalmoscopy, and therefore holes may remain unnoticed. Repeated operations will be difficult partly because of the reason already mentioned and partly because of the solid adhesions between the eyeball and the surrounding tissue. Larsson,[3] Shapland [4] and others, however, have reported satisfactory results obtained with the method of surface coagulation.

Šafář's [5] pins are short, being just long enough to pierce the sclera, and his excellent results seem to justify his method. Walker [6] uses pins too, desiring to obtain a combined effect. He carries out micropuncture with the tip of the pin, while an electrical nonisolated stopping plate of the needles causes surface coagulation on the sclera. The combined method is used also by Weve,[7] who first produces surface coagulation with a blunt electrode and then carries out micropuncture with short pins. In the case of cystlike detachments, when the retina is bulged deep into the vitreous, Weve often uses pins 3 to 4 mm. long. Though this procedure may sometimes be rather dangerous, as the retina may be damaged by the tip of the pin, yet he seems to have obtained most excellent results with this method.

Opinions differ as to the piercing depth of diathermic pins. Meesmann [8] expressed the belief that the effect of diathermic coagulation of the retina is very beneficial. He runs the pin close to the retina and uses a current of an intensity and duration just sufficient to produce a small gray-white focus on the retina.

A healing effect from the diathermic current can be expected only if the dose is kept within definite limits; underdosage or overdosage may do harm. Ophthalmologists therefore endeavor to check the dosage. As the heat is due to the diathermic (electric) current, it might seem that the dosage could be controlled by measuring and adjusting the intensity, i. e., the milliamperes, of the diathermic current. This method has been proposed by different authors, yet their experience was that while they used the same milliamperage and disregarded some other circumstances different degrees of coagulation resulted. Obviously, coagulation depends not only on the intensity of the diathermic current but also on many other factors, such as the humidity of the sclera and the electrical resistance of the tissue.

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3. Larsson, Sven: Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:113, 1935.

4. Shapland, C. D.: Brit. J. Ophth. **18**:1, 1934.

5. Šafář: Behandlung der Netzhautabhebung mit multipler diathermischer Stichelung, Berlin, S. Karger, 1932.

6. Walker, C. B.: Am. J. Ophth. **17**:1 (Jan.) 1934.

7. Weve, H.: Ann. d'ocul. **171**:1, 1934.

8. Meesmann, A.: Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:121, 1935.

Though opinions differ regarding the various modes of diathermic operation, most authors acknowledge that as yet diathermy is the most suitable way for healing retinal detachment. However, Vogt has stated that diathermy is dangerous and should be abandoned. He is looking for a new method and thinks that he may find it in electrolysis, which was applied first by Imre [9] and later by von Szily and Machemer.[10] His arguments against the use of diathermy are: (1) A very high temperature (more than 1,000 C.) is produced on the site of the puncture, due to sparks, which may easily occur at the customary intensity of from 50 to 120 milliamperes, and (2) in case the tip of the pin penetrates deeper into the eye it may remain cold; the detached retina may be punctured without the production of coagulation, and new detachment will ensue.

Vogt's objection to diathermy lent a special interest to research in the physics of diathermic coagulation. Apart from this the question would have arisen, as complete control of the dosage could not be based only on the ground of the knowledge of the physical happenings during the process of coagulation. Investigations concerning diathermic coagulation have been made hitherto mostly from the histologic point of view. Only a few of them dealt with the physical process; e. g., Coppez in his experiments observed the distribution of diathermic heat and endeavored to find a relation between the different factors of diathermic coagulation and that of the heat produced.

I found in some tests that the electrical resistance of the eye is closely related to the state of coagulation. Further investigations proved that when diathermy is not applied the value of resistance is practically independent of the condition of the eye of the patient, and its variations during the operation show clearly the process of coagulation. My co-worker and I found an easy means of measuring the resistance during diathermic application and by this obtained some new light on diathermic coagulation.

A NEW METHOD OF MEASURING RESISTANCE IN TISSUE UNDER TREATMENT WITH HIGH FREQUENCY ENERGY, WHICH MAY BE USED AS A MEANS OF ADJUSTING DOSAGE

HEINRICH KALMUS

It was possible adequately to utilize the beneficent action of roentgen rays only after suitable apparatus for controlling roentgen dosage had been devised. Those who attempt to use high frequency currents (for surgical or other therapeutic procedures), diathermic currents or currents of any other similar type are confronted with the same problem of suitable apparatus. A new dosage is described here

9. Imre, J.: Klin. Monatsbl. f. Augenh. **89**:545, 1932.

10. von Szily, A., and Machemer, H.: Klin. Monatsbl. f. Augenh. **90**:806, 1933.

which, although originally developed for the special purpose of interference in ablatio retinae, may be utilized for a whole group of other diathermic operations. Thorough testings have been made with the collaboration of Dr. Klein.

The present day methods of dosage are so extremely unreliable that the successful outcome of an intervention has come to depend largely on the skill of the individual physician. The action of a high frequency current on the tissue has been measured solely in terms of the current's intensity as registered on a heated wire or thermocross instrument and by the duration of the application. The onset of coagulation may well be manifested by discoloration at the point of puncture but, as the appearance of this area is not altered by further action, no satisfactory conclusion can be drawn with reference to the effect exercised by the current—an effect which, as a result of the sparks given off, may inflict serious damage. Not long ago an attempt was made to improve the technic of dosage, but no complete solution of the problem has been effected thereby. This method substituted for the ordinary needle an instrument of puncture having two metals soldered together at its tip. The soldered area forms a thermal element that may be applied after the instrument has been connected with the apparatus and with a compensation cell which aids in the maintenance of a constant temperature of the room and of the tissue and may be placed in the immediate vicinity of the punctured center.

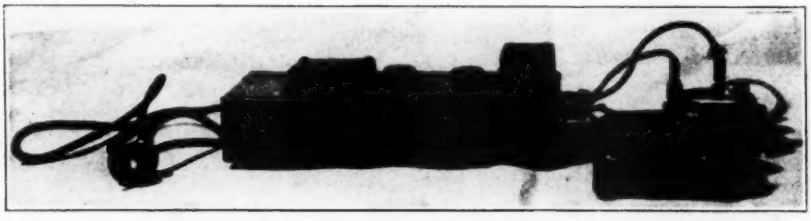

Fig. 1.—The measuring apparatus.

Unfortunately, the foregoing method has two disadvantages. In the first place, owing to the use of two metals soldered together, the point is less fine than that of a single, uniform needle. Secondly, the temperature of the center of puncture cannot be as quickly determined; the point acquires a lag of heating due to the length of time required for the heating process. Certain harmful aspects of the treatment with current, flying sparks for example, are not as a rule to be observed.

Our new apparatus provides for measurement of the ohmic resistance in the treated tissues and makes possible the constant observation of the tissue alterations throughout the operation. The heat of the high frequency current produces both desiccation, that is, reduction in the water content, and chemical alterations in the tissue. One such chemical change is the congealing of the protein which characterizes coagulation. Both desiccation and coagulation result in a marked change in the ohmic resistance and, from the observation of these phenomena, the effect of the high frequency current may be judged.

The resistance is determined by computation of the voltage. A steady measured current flows through the tissue together with the high frequency current and by this measured current the decrease in voltage which the current undergoes as a result of resistance is computed. Naturally, caution must be taken that no contrary influence on the circulation of the high frequency and measured currents is present.

It suggests itself as most probable that the measured current should be a direct current. Experimentation has shown, however, that owing to phenomena of polarization uncontrollable electromotive forces enter between the electrodes and prevent the accurate measurement of resistance. For this reason a 50 period alternating current was used, and a tubular voltmeter selected as indicator of the tension. This instrument should be insensitive to direct tension, and in this way the inaccuracies of the older methods will be eliminated.

The magnitude of the measured current is so restricted that it cannot provoke excitement of any kind. In numerous experiments with animals the maximal value permissible was 0.2 milliampere. For the dosing apparatus a value of only 0.1 milliampere was selected in the interest of safety.

The entire measuring system consists of three parts: a high frequency-measured current switch for separation of the two currents, the transformer and the instruments for supply and regulation of the measured current and finally the highly sensitive tubal voltmeter for measurement of the measured current and of the drop

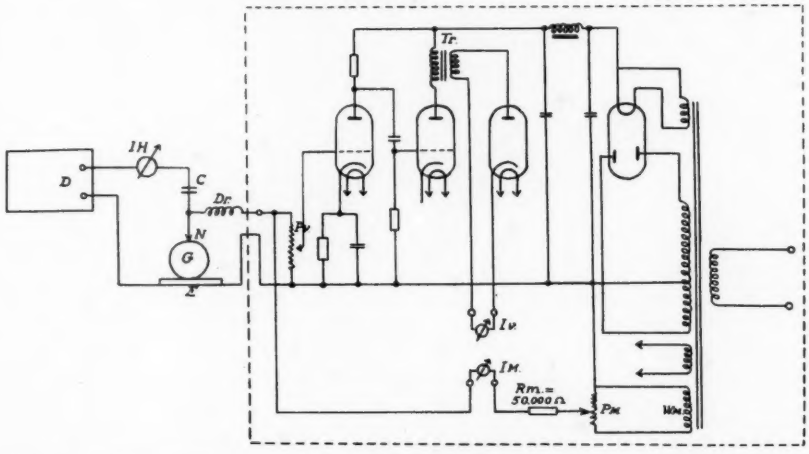

Fig. 2.—Construction of the measuring apparatus connected with the diathermic apparatus. The designated parts are: *D*, diathermic apparatus supplying high frequency current; *IH*, measuring instrument; *C*, condenser; *N*, operating needle; *G*, tissue (enucleated pig's eye) being treated; *E*, grounded plate; *Dr*, choke; *Pv*, potentiometer; *Tr*, transformer; *Iv*, ampere meter for diode current; *IM*, ampere meter for the alternating current (measured current); *RM*, fixed resistance; *PM*, potentiometer; *WM*, secondary winding for alternating current (measured current).

in potential in the tissue under treatment. With the exception of the switch, which must be connected directly with the operating needle in order to avoid loss of capacity in the high frequency current, the other parts are attached to a compendious apparatus connected with the electric current and easily so constructed as to form one unit with a diathermic apparatus.

The complete arrangement of the measuring apparatus is to be seen in figure 2. The section of switch bounded by the broken lines is built into the aforementioned apparatus.

The diathermic apparatus *D* supplies the high frequency current which flows by way of the instrument *I H*, the condenser *C*, the operating needle *N* to the tissue (in the experiments described in this paper, an enucleated pig's eye) under treatment, then through inactive electrode *E* back to *D*. Coil *W M* of the current transformer supplies the measured current. The potentiometer *P M* serves to

regulate the tension. By this procedure the measured current is made to flow by way of the resistance *R M*, a milliamperemeter *I M* and a high frequency coil of great impedance *Dr* (which weakens or suppresses alternating currents) into the operating needle. Thence it flows through the tissue under treatment back again to the transformer by way of the inactive electrode. The magnitude of the measured current is maintained constant by the resistance *RM*, the value of which is many times greater than that of the tissue resistance, some 50,000 ohms against 5,000 ohms. Therefore, the drop in potential suffered by the measured current in the tissue is directly proportional to the tissue resistance. The high ohmic potentiometer *Pv* is attached to the coil of impedance parallel to the tissue. Some of this tension is exhausted at *Pv* and conducted to the screen of the first tubes. These tubes function as strengtheners of resistance. From the anode an increased potential passes through a condenser and the screen of the second tubes, is here further strenghtened and finally flows through a transformer to a diode, where it is rectified and measured with an ordinary rotary spool. The transmission-transformer between the tubes and diode functions so perfectly that the greatest possible diode resistance is adjusted favorably to the tube resistance, and the tubes may function to capacity.[11]

The new dosage method assures more favorable results from the use of high frequency currents in operative interventions. In many situations in which the point of puncture is not at all visible (in operation on the trigeminal nerve, for example) the new apparatus makes possible, above all, a calculation of the magnitude of a current and the time required for its application quite independent of the physician's private judgment.

Figure 4 depicts a dosing apparatus with the mechanisms for the regulation of measured current and diode current.

[It should also be mentioned that a loud-speaker is connected with the rectified current, which gives a crackling tone if sparking occurs; this takes place when the coagulated spot becomes dry, and at the same time a sudden change of resistance can be observed. The loud-speaker signals the presence of sparks long before they could be detected by the eye.—M. K.]

RESULTS OF TESTS

The experiments made with the new apparatus described by Mr. Kalmus in the preceding section were expected to yield information about the following points: (1) the physics of coagulation and (2) the value of the different methods and theories of diathermic operation described in the ophthalmic literature.

1. *Physics of Coagulation.*—In the experiments my co-worker and I examined the methods that are commonly employed in operations, namely, (*a*) micropuncture and (*b*) surface coagulation.

(*a*) Micropuncture (Microcoagulation): As has already been mentioned, there are several factors which influence coagulation. There would be no use in changing all of them at the same time, but some variables should be kept constant during the test, and others should be changed. In our experiments we kept all the factors constant except

11. Mr. Kalmus, engineer, worked out this method of measuring resistance and constructed the apparatus for this purpose, and the engineers Mr. Márkus and Mr. Stern assisted in the performance of the experiments.

the diathermic current and the electrodes. Through this arrangement the relation of the diathermic current and the resistance of the eye could be exactly determined. The characteristics of the variation of resistance with time can be determined by means of measurements with different diathermic currents.

The pins used were provided with a stopping disk of ruby, which is a good isolator. They had a thickness of 0.15 mm. and a length of 1.8 mm.

After piercing the sclera with the pin we first measured the resistance of the "cold" eye, and afterward we connected the diathermic current. The resistance decreased immediately after the diathermic current was introduced into the eye and remained on this lower level for some time. When coagulation was finished the coagulated area became dry, and the electrical resistance increased steeply and reached a value which was very high in proportion to the initial value. The

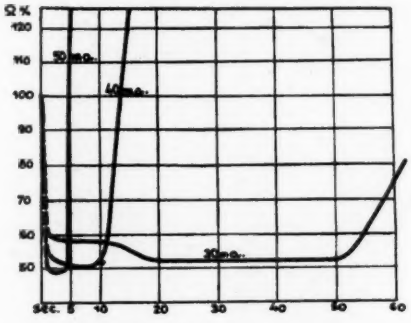

Fig. 3.—Variation of resistance with time for different values of high frequency current measured with needle electrodes.

part of the curve for the variation of resistance with time in cases in which the resistance remains low is the shorter the higher the intensity of the diathermic current applied (fig. 3). Though the variations in resistance depend largely on the circumstances of the test, it is expected that similarly shaped curves with changed valves for the variation of resistance with time will be found if the circumstances are altered.

The results of the tests in detail are as follows:

In a group of the tests we applied 20 milliamperes of diathermic current; the initial resistance was 5,000 ohms. Under the influence of this current the resistance fell first to 3,500 ohms and then to 3,000 ohms, where it remained. We watched the eye as long as from forty to one hundred and seventy seconds after the connection of the current. The resistance was practically constant during this time. On the site of coagulation some scarcely visible alterations of the sclera took place, without drying up the coagulated area, in which case the resistance would obviously have risen.

Next we increased the current to 30 milliamperes. For instance: The initial resistance was 4,500 ohms. During coagulation the resistance fell to 2,400 ohms first and then became constant at 2,100 ohms for a time. Within from sixty to seventy-five seconds after the start the coagulated area dried up, and the resistance rose accordingly to 3,000 ohms and further to 7,000 ohms. Continuing the observation, in some tests we found values above 50,000 ohms. If one compares the results of this test with those of the former one, one sees that the difference is but quantitative. In the latter test the coagulation was more marked and was accompanied by the drying up of the coagulated area and the rise of resistance as shown in the curve.

Then we increased the current to 40 milliamperes. The initial resistance of 4,500 ohms soon fell to 2,100 ohms, and coagulation reached the period of drying up more rapidly. The resistance began to rise in about from ten to fifteen seconds.

With a further increase of the current of about 50 milliamperes coagulation took place in from three to five seconds, and if the current was adjusted to any value above 50 milliamperes coagulation took place so rapidly that it could not be observed. This means that the applied current must not exceed the proper value (in the test in question, about 30 milliamperes), else overdosage and consequent harm to the eye may occur.

During the tests just described in the period of drying up we could hear continuous crackling by the loud-speaker, signaling the presence of sparks, though no spark could be detected by the eye. The loud-speaker proved very useful in these tests, as sparks were signaled at the moment of their development.

In analyzing the characteristics just described four periods can be distinguished:

1. A period of rapid fall of the resistance, which occurs as soon as the diathermic current is connected. This part of the curve was drawn on the charts with dotted lines. Owing to the suddenness of the drop in resistance, the exact relation of resistance and time could not be noticed.

2. A period of a steady state of resistance on a low level. This period lasts till the coagulated area becomes dry.

3. A period of a sudden rise of the resistance. This is the period of thorough drying up. In this interval small sparks usually occur. They are invisible but are detected by the loud-speaker.

4. A period of carbonization of the tissue. In this period of coagulation the resistance rises to extremely high values, and damage of the tissue is conspicuous, though the degree of destruction cannot be easily estimated.

It is hard to judge whether the observed sparks are harmful or not. The damaged part of the tissue can be considered rather negligible in relation to the bulk of the eye. It is a question, however, whether such a delicate organ as the eye can suffer such injury, even on a small area, without danger. From the purely physical point of view one can state that in the presence of sparks control over the high frequency current is made impossible.

The tests already described have been made repeatedly, and the process of coagulation was nearly similar in each case at any of the adjusted milliamperes of current. The results can therefore be reproduced. It must be stated, however, that a similar process of coagulation can be obtained in such cases only when the circumstances of the test, i. e., those of the operation, are standardized, because both the process and the degree of coagulation depend on such circumstances as the milliamperage, the electrodes and the depth of piercing.

(*b*) Surface Coagulation: The arrangement of the experiment described under *a* was kept unchanged except for the pins, which were replaced by blunt electrodes 0.8 mm. in diameter. If the sclera is dry the initial resistance of the eye measured by means of such an electrode is rather high. After the diathermic current is switched on, even with a current of not more than 20 milliamperes, the resistance rapidly rises to values so high (over 50,000 ohms) that measurement is difficult. The explanation of this fact is that a thin film of scorched tissue develops rapidly on the dry sclera, and this film is a bad conductor. Soon sparks of visible intensity develop, and at the same time the milliammeter shows a drop of the current sometimes nearly to zero. That is a consequence of the efficient rise of resistance.

Most authors suggest the use of a current of about 100 milliamperes. If one did not take into consideration the mentioned change of current and persisted in using the proposed intensity of 100 milliamperes by readjusting it with the regulating knob, the output of the diathermic apparatus would soon exceed the limits of that for a surgical operation. The milliammeter is useful in this case too, since by showing the rapid drop of current it gives some indication as to the state of coagulation and prevents one from readjusting the current, which would lead, of course, to overdosage. One learns from the process described that no full information can be obtained regarding coagulation by the use of the milliammeter alone, however useful this instrument may be.

Frank Flynn's method proved very good, as was demonstrated by further experiments. According to this method the sclera is moistened with distilled water all the time during surface coagulation. After the connection of the current the behavior of the resistance is similar to that we have seen when pin electrodes have been used; that is, after a

rapid fall the resistance remains permanently low. As the continuous moistening of the sclera prevents the area of coagulation from drying up, the rising part of the curve is missing. Some results of this test at different intensities of current are as follows:

With a current of 50 milliamperes, after the connection of the current the initial resistance was suddenly reduced by from 12 to 14 per cent, and during sixty seconds' observation a slight, hardly visible area of coagulation had formed. No shrinking could be detected.

With a current of 70 milliamperes the process was similar, but the change in the color of the sclera was more conspicuous, and in about thirty seconds shrinking could be observed.

With a current of 80 milliamperes the drop of resistance was from 18 to 20 per cent, and its value remained constant for the observation time of sixty seconds. The sclera was characterized by rapidly growing change of color, coagulation and marked shrinking. If coagulation went on, moistening was no longer able to prevent shrinking of the sclera. This shrinking was the more intensive the greater the applied current. At a current of 100 milliamperes shrinking took place suddenly (in from two to four seconds). With a very strong current it was impossible to prevent sparks and carbonization by the usual moistening.

It seems from this series of tests that if the sclera is dry it is rapidly scorched by surface coagulation. The carbonized layer then prevents coagulation from spreading into deeper layers; besides sparks develop which may harm the eye.

If, on the contrary, the coagulating spot is moistened, carbonization is avoided. This method might be called endothermic, because the generated heat is propagated into the deeper layers of the eye too. With the aid of this method coagulation seems to have a greater effect on the choroid. It can be concluded from the foregoing observations that surface coagulation must not be employed without moistening the sclera. It must be mentioned, however, that only distilled water may be used for moistening, since salt components or serums render the electrical resistance of water too low.

2. *Methods Mentioned in the Literature.*—Some differences are found in the literature regarding the features of the operation. By further experiments, which are described in the following paragraphs, one is able to compare the merits of the different methods and their principles.

Some ophthalmologists lay stress on keeping the sclera dry, if the operation is carried out with pin electrodes. The liquid film on the eye is supposed to lead away the high frequency current and thus weaken the effect of coagulation. Our arrangement enabled us to solve this problem. Should the liquid film cause leakage the electrical resistance

would fall. So we pierced the sclera with the same pins as were used in previous experiments and measured the resistance. Then we dropped physiologic solution of sodium chloride on the sclera, but there was no change in the resistance. This is easily understood, considering that the part of the pin in contact with liquid film is small in proportion to the part pierced into the sclera (fig. 4). In case the liquid covered the isolating stopping plate and brushed the upper part of the pin (as is shown in figure 5) the expected drop in resistance took place. The same observations could be made after connecting the diathermic current. If one drops physiologic solution of sodium chloride on the sclera during the period of low resistance the resistance does not change unless the solution reaches the upper part of the pin or if the isolation of the stopping disk is damaged (e. g., if the enamel of the metal disk is peeled

Fig. 4.—Diagram showing pin in contact with the liquid film and piercing the sclera.

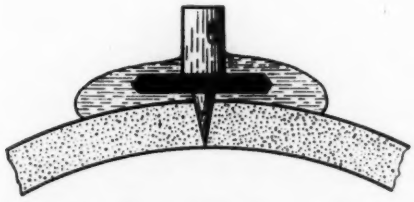

Fig. 5.—Diagram showing the liquid film covering the stopping plate of the pin.

off). The observations reported in the literature that similar coagulation can be obtained only if the sclera is kept dry seem to be due to such stopping plates, which enable the liquid film to touch a larger conducting surface.

It is important to learn what occurs when the pin is pierced through the fibrous shell of the eye and is pushed into the aqueous or vitreous part. We made the experiment with a longer unisolated pin, piercing as deep as 5 or 6 mm. The initial resistance was rather low. At a current of from 4 to 6 milliamperes no coagulation could be detected during a considerably longer time. If the current was increased up to 100 milliamperes coagulation developed in the neighborhood of the pin in the sclera as well as in the cornea, but practically no warming up of the deeper layers could be detected.

If the experiment is carried out in the way in which such operations used to be performed, i. e., if the diathermic current is connected first and the pin is pricked afterward, the process of coagulation is similar to the process that has already been described as long as the pin does not pass the sclera or the cornea. (This holds true in the case of a moderate current only.) However, as soon as the tip of the pin enters the vitreous coagulation ceases. Walker made similar observations. When the pin is in the aqueous or vitreous part it appears to behave like a thermocautery, which is hot in the sclera but cools down in the vitreous part. The main difference is that in the case of the thermocautery cooling is caused by leakage of heat, whereas in the case of the diathermic pins cooling is most probably caused by leakage of current through the vitreous, the resistance of which is lower than that of the sclera. As a result it may be stated that pins used in operation for retinal detachment must be equipped with a stopping plate to insure the proper depth of penetration. Besides, all pins used in ophthalmologic operations must be of the same thickness (the same surface) if the same effect is required with the same current.

There have been some attempts to use cutting current in coagulation recently; so we extended the investigations to this method. Even with a very low current, coagulation rapidly develops on the spot of piercing, and the resistance rises. The cause lies in the carbonization of a thin layer of the tissue touched by the pin. Thereby the resistance rises, and at the same time sparks develop. Cutting current therefore is unfit to be controlled either with a milliammeter or with any other device. Consequently the use of this method is not desirable.

THEORETICAL CONSIDERATIONS

Hitherto in the experiments described only two variables were investigated, namely, the electrical resistance and the intensity of the diathermic current. Other factors were left out of consideration by keeping them constant for each test. There are, however, many such factors which may influence the process of coagulation, and these should be considered when carrying out the diathermic operation. Information regarding these factors has been acquired partly by experience and partly by experiments. Investigations regarding these factors have been made by Weve, Coppez, Meesmann and other investigators, and it is well known today that the shape and size of the electrode, the piercing depth of the pin electrode, the specific heat and resistance of the tissue and the duration and frequency of the diathermic current have a marked influence on the development of coagulation. Jess suggested the use of high frequency current, though this should not be too

high because, according to his experience, current of lower frequency, is more suitable to produce coagulation. Weve has employed a frequency of 4,500,000 per second, but recently he informed me that lately he has been employing current of lower frequency.

In the choosing of frequency the most important point which should be considered is its strict relation to capacity current, which makes the determination of a proper dose difficult and may render the milliammeter useless for the control of the dosage at high frequencies.

D'Arsonval's experiment demonstrated clearly how much capacitive current may influence the results of the test. He placed in a glass jar two parallel plates of platinum as electrodes at a distance of 20 mm. apart, filled up the jar with solution of sodium chloride and changed the concentration of the liquid during the experiment to such an extent that he could change the resistance between these electrodes from 13 to 35,000 ohms. He connected high frequency voltage to the electrodes and observed the temperature of the liquid. The temperature naturally varied with the resistance, even if the current was kept constant. It was interesting, however, that this variation of temperature was not more than 8 C. when the variation in resistance was as large as from 1,500 to 2,500 ohms. The results obtained by d'Arsonval were correctly interpreted by Fabry, showing that the milliammeter indicates the sum of the currents passing through the ohmic resistance and the current. Capacitive current does not generate heat, and this part of the total current is the larger the higher the frequency. D'Arsonval's experiment cannot, however, be simply applied to the human body, because the opposite plate electrodes placed rather close to one another and the dielectric formed by the solution of sodium chloride increase the capacitive current far above that found in operations.

The uncertainty caused by capacitive current in regard to the dosage is further increased by the fact that the total current as read on the milliammeter is equal not to the arithmetical sum of the ohmic and capacitive currents but to the square root taken from the sum of the squares only. One may conclude that for not very high frequencies the reading of the milliammeter fairly approaches the actual value of the useful current.

A further argument against the control of the dosage by the milliammeter is the individual difference between the resistance of the eyes of different persons, the generated heat being proportional to the resistance. We measured the resistance of several human eyes and found that the difference seldom exceeded 10 per cent. We do not think, therefore, that the milliammeter should be discredited.

PYROMETRIC SUPERVISION

Some ophthalmomologists, dissatisfied with the results obtained with the milliammeter as a control, looked for other means of control. Larsson and Weve watched the reaction of the tissue in order to determine the proper dose of current. They increased the current until the sclera became parchment-like and a grayish-white coagulative spot appeared on the fundus. Coppez and, later, Meesmann, on the basis of research, suggested measuring the temperature of the eye on the site of origin of the heat by means of their special thermometric electrodes. It is a known feature of metals that whenever the soldered contact surface of two different metals is warmed up electric current is generated which is proportional to the difference in temperature between the contact surface and the room. If this electric current is measured by means of a galvanometer, the actual temperature of the contact surface can be computed in a simple manner, or the instrument itself can be calibrated in degrees of temperature. This so-called pyrometric principle has been employed by Coppez and Meesmann for measuring the temperature of the tissue during treatment. Coppez uses surface electrodes, while Meesmann uses pin-shaped ones.

In order to obtain the relation between electrical resistance and the temperature of the sclera and to check at the same time the advantage of the pyrometric method, we extended our investigations to such operations.

We used Meesmann pins only. We do not rely on the practical use of Coppez electrodes, for two reasons: 1. The use of the thermocouples on the surface makes it impossible to employ moistening, because, owing to its cooling effect, readings would be wrong. It has already been shown that the surface method is harmful if it is employed without moistening. 2. The thermo-electric pins, like all heat-measuring instruments, suffer from inertia; i. e., they react to the variations of temperature rather slowly. The retardation is the longer the larger their mass. This behavior of thermo-electric pins was pointed out by Coppez and Meesmann. Meesmann succeeded in designing his pins small enough to keep this inertia sufficiently low. Surface electrodes are much larger than pins; therefore their use as thermocouples does not appear to be justified.

We used the Meesmann pins for our tests. The process of coagulation, as could be seen from the curves for resistance, is the same as when the usual micropins are used. After connection of the diathermic current the resistance rapidly falls, remains constant on a lower level for a while and then rises again in consequence of drying up of the coagulated area, and at the end sparks occur.

The particulars of these tests are as follows:

With a current of 30 milliamperes the curve for resistance was stretched, and no slope appeared. The temperature of the sclera did not exceed 55 C. during an observation time of thirty-five seconds.

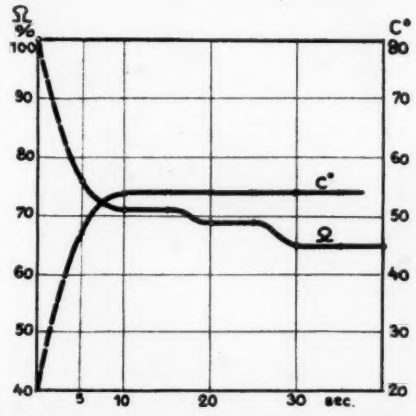

Fig. 6.—Variation of apparent temperature and resistance with time when a high frequency current of 30 milliamperes was used. The temperature was measured by means of pyrometric electrodes.

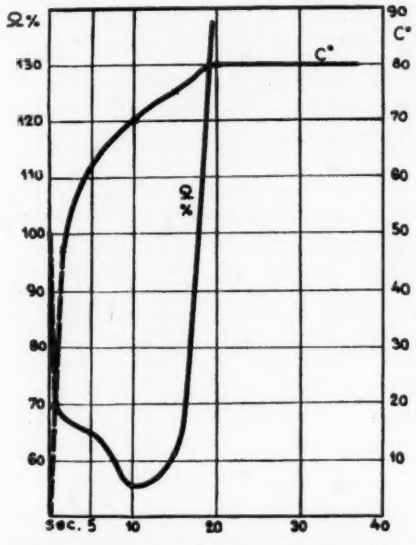

Fig. 7.—Variation of apparent temperature and resistance with time when a high frequency current of 38 milliamperes was used. The temperature was measured by means of pyrometric electrodes.

With a current of 40 milliamperes a temperature of 75 C. was indicated in four seconds. The resistance rose rapidly, and sparks occurred. Since a temperature of 75 C. does not explain the develop-

ment of sparks, retardation in the measurement of temperature must be supposed. After a few further seconds a rise of temperature could be read, but by this time exsiccation was already conspicuous.

Other tests displayed a further disadvantage of the pyrometric method. It may happen that, owing to the size of the pin or some condition of operation, the pin does not lie entirely in the sclera but part of the soldered surface is left in the air or the tip of the pin penetrates into the vitreous. Further, thermocouples have low electrical resistance and thus are not heated by the current itself but by the tissue only. Therefore, if partly heated they will not indicate the temperature of the sclera, but an average temperature between the temperature of the sclera and that of the air or the temperature of the vitreous part. This behavior was clearly demonstrated in the respective

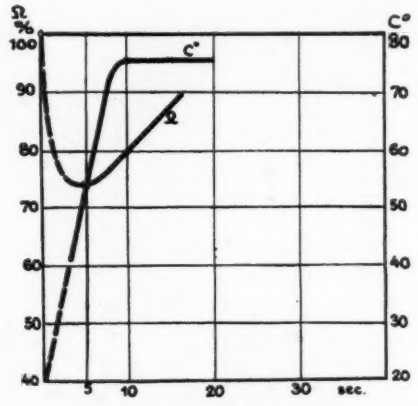

Fig. 8.—Variation of apparent temperature and resistance with time when a high frequency current of 40 milliamperes was used. The temperature was measured by means of pyrometric electrodes.

curves for resistance and for temperature obtained during these tests. This disadvantage is, of course, eliminated if the soldered contact surface lies entirely in the sclera.

One learns from these tests that while the pyrometric method gives valuable data about the process of coagulation it does not satisfy the requirements of a proper control of the dosage if used unaccompanied by some other measurement. If used alone it may easily deceive the operator about the true state of coagulation, since as we could see sparks and carbonization occurred before the rise in temperature was indicated by it. Its use would be greatly facilitated if the size of the pins could be diminished to the size of pins used in micropuncture.

Contrary to the pyrometric method, the measurement of the resistance appeared to be, as might be expected from the theory, instantaneous, inertialess and reliable in every respect. The horizontal part

of the curve insures sufficient time for the surgeon to watch the coagulation, and the current can be disconnected before the drying up of the sclera, i. e., before the rise of the curve for resistance begins. After some experience this method of measuring resistance will be found to be easy, especially if the apparatus and diathermic current remain unchanged through a series of operations.

COMMENT

The success of the operation for healing retinal detachment depends chiefly on the diathermic coagulation, since the irritation producing adhesive choroiditis is the effect of coagulation. It is important that the irritation be kept between certain limits, because violent as well as too weak irritation may do harm. As far as we could see, there are several important factors influencing coagulation. The individual factor of the eye under treatment may be disregarded, as a careful choice of method and dosage insures the reproduction of such operative conditions as have been proved by former experiences of the surgeon. Four factors should be kept in mind:

(1) the type and shape of the electrodes;

(2) the diathermic-apparatus, i. e., the generator of the high frequency current;

(3) the frequency of the current, and

(4) the rate of the current.

1. *Electrodes.*—The heat generated depends on the amount of the surface of the electrodes touched by the tissue and on the piercing depth of the pins. The shape and size of the electrodes should be the same for all operations. If micropuncture is employed the pins should be as thin as possible, and the piercing depth should be the same for all the operations. To insure the proper depth of piercing the best practice is to provide the pin with an isolated stopping plate. If surface coagulation is applied the electrode and the pressure of the hand should be the same for all the operations. On the application of surface coagulation one should never omit moistening the sclera, in order to avoid rapid drying up and irregular coagulation.

2. *Diathermic Apparatus.*—The surgeon should use only that type of diathermic apparatus the operation of which is thoroughly known to him. It will be found useful to calibrate the apparatus for power of coagulation by the method employed in the tests already described. Although the electric power required for the operation is rather low, the use of a high power apparatus is recommended, in order to avoid fluctuations of voltage when the load is varying.

3. *Frequency of Current.*—High frequency current seems to be more suitable for the production of coagulation than low frequency

current. It must be noticed, however, that should the former be employed the proper adjustment of the dosage will be more difficult. This is obvious from the following considerations: The milliammeter of the apparatus shows in most cases the total current afforded by the apparatus. Capacitive current may leak partly from the leading-out wires of the apparatus and partly from the eye itself. This current does not take part in the heating of the eye, and the larger is the portion it forms the higher the frequency of the total current. The fault caused by capacitive current is essentially diminished, and it can be diminished still more if one calibrates the apparatus according to the suggested method of the measurement of resistance.

4. *Rate of Current.*—It is seen from the results of the test that the duration of the horizontal part of the curve for resistance can be influenced by adjusting the rate of the current. If the current is low, coagulation will be too slow, and the required time of operation will be inconveniently long. If it is high, carbonization may occur so rapidly that one may easily miss the proper time to disconnect the current and may harm the eye. We found it best to adjust the current to a value involving a coagulation time of from four to six seconds. The duration of the operation has, further, an influence on the process of coagulation. The extension and depth of the coagulating area increase in proportion with the duration of the procedure, which is, however, advantageous to a certain limit only.

We found that the optimal current taken from the surgical diathermic apparatus described amounted to about 30 milliamperes for micropuncture and from 50 to 70 milliamperes for surface coagulation. It is possible that this value would differ somewhat if another apparatus were used; e. g., 50 milliamperes read on an apparatus may have an effect equal to that of a current of 60 milliamperes of another apparatus. It would be appropriate if some standardizing station would calibrate all such apparatus according to equal effects, using standard electrodes and standard substitutes for the living eye.

CONCLUSIONS

The chief purpose of our experiments was to find out whether the dose in diathermic irritation can be specified and whether the specified dose can be accurately adjusted during the operation and, further, to find available means to do so.

Both questions may safely be answered in the affirmative. The result of our experiment furnished the proof that the dose can be specified and adjusted on the basis of the milliammeter reading when it is supposed that the apparatus has been calibrated for the coagulating capacity with the same arrangement and same electrodes used for car-

rying out the operation. Larsson went still further and tried to abandon the use of the milliammeter. We do not agree with him. It is admitted that the current can be adjusted for all similar operations, and a milliammeter reading seems to be superfluous. It was found, however, as mentioned in this paper, that the reading gives an indication of the variations of current and of the drying up of the coagulating spot.

It must be stated, however, that the milliammeter reading alone is not to be relied on solely. Biologic control of the process by ophthalmoscopy is required during operation. While the proper dosage is adjusted by electrical methods the results are checked by ophthalmoscopy to determine whether the desired effect has taken place on the desired spot.

From the results of the research described in this paper it may be stated that the dosage of diathermic coagulation can be checked and the dangers indicated by Vogt can be easily avoided.

OCULAR SIGNS OF THROMBOSIS OF THE INTRACRANIAL VENOUS SINUSES

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While the ocular signs of thrombosis of the cavernous and lateral sinuses are well known, there is not complete agreement regarding the mechanism producing them. The ocular changes of thrombosis of the superior longitudinal sinus are less thoroughly understood. Some of the conditions hitherto diagnosed as serous meningitis, pseudotumor of the brain or chronic arachnoiditis may be due to thrombosis of the venous sinuses in the presence of an abnormal venous sinus pattern. In this paper the ocular signs of thrombosis of these dural sinuses are described, and an effort is made to correlate some of these with the anatomicopathologic findings in septic thrombophlebitis of the cavernous and lateral sinuses.

In approaching the subject I shall first review the relevant pathologic and anatomic features.

PATHOLOGIC PICTURE

Thrombi may be aseptic (primary, marantic or autochthonous) or septic.

The aseptic form of thrombosis occurs usually in the superior longitudinal sinus, less frequently in the lateral sinus and least frequently in the cavernous sinus (Uhthoff).[1] Septic thrombosis occurs most often in the lateral sinus. The septic form is more common than the aseptic. Macewen[2] in 1893 differentiated these forms as follows: Aseptic thrombosis characteristically (1) occurs in the nonpaired sinuses, (2) is rarely associated with purulent infection, (3) shows a tendency to organization or resorption, (4) is rarely complicated by meningitis and (5) in one-half the cases is followed by extravasation into the brain and a tendency to softening. Septic thrombosis is characterized by (1) occurrence in the paired sinuses, (2) frequency of purulent infection, meningitis and cerebral abscess, (3) a tendency to

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From the Wilmer Ophthalmological Institute, the Johns Hopkins Hospital.

Read before the Ophthalmological Section of the New York Academy of Medicine, May 18, 1936.

1. Uhthoff, W., in von Graefe, A., and Saemisch, E.: Handbuch der gesammten Augenheilkunde, Berlin, Julius Springer, 1911, vol. 11, p. 697.

2. Macewen, W.: Pyogenic Infective Diseases of Brain and Spinal Cord, Glasgow, J. Maclehose and Sons, 1893, p. 226.

purulent degeneration of the thrombus and (4) rare occurrence of extravasations into the cerebrum and cerebellum.

Thrombosis and phlebitis are usually regarded as reciprocal processes. The relative importance of slowing of the blood stream and infection of the vein as causative factors was a subject of debate until Welch showed that infection of the vein precedes the formation of the thrombus in most cases. Aseptic thrombosis may occur as a result of injury, but it may also occur as a result of changes in the blood itself or from dehydrating diseases.

Ordinarily thrombi grow in the direction of flow of the blood stream, but they may develop in the opposite direction. Such retrograde development is frequent in the intracranial venous sinuses, where it may be accounted for by the absence of valves in many of the venous channels as well as by the plentiful collateral circulation.

Thrombi may cause vascular obstruction. Such obstruction accounts for certain of the ocular signs and may result in damage to the brain through infarction, necrosis and hemorrhage. Septic thrombi result in bacteremia and septicemia and through direct extension may give rise to abscess of the brain and meningitis.

Septic thrombophlebitis is constantly accompanied by edema of the surrounding tissue. This edema is due, for the most part, to lymphangitis (Boyd [3]).

ANATOMIC PICTURE

The cavernous sinus is situated at the side of the body of the sphenoid bone. It extends from the superior orbital fissure to the tip of the petrous portion of the temporal bone, a distance of slightly more than 2 cm. The sphenoid sinus lies medially, and the middle cranial fossa with the temporal lobe lies lateral to it, while the hypophysis lies medial to and above it. The sinus is made up of many compartments, which become fewer as age advances. It contains the carotid artery and the sixth nerve, which lies lateral to the artery. The third, fourth and ophthalmic (sometimes the mandibular as well) divisions of the fifth nerve lie in its lateral wall in that order from above downward. Anteriorly it receives the sphenoparietal sinus, the superior ophthalmic vein, which in turn receives the anterior and posterior ethmoid veins and veins from the frontal diploe, and the inferior ophthalmic vein, which drains the outer portion of the floor of the orbit. The inferior ophthalmic vein communicates with the facial veins and with the veins of the pterygoid plexus. The middle cerebral vein and veins from the hypophysis and from the sphenoid sinus empty directly into the cavernous sinus. Through communications with the precentral and

3. Boyd, W.: Surgical Pathology, Philadelphia, W. B. Saunders Company, 1925, p. 141.

postcentral veins, which empty into the superior longitudinal sinus, the middle cerebral vein establishes communication between the superior longitudinal and the cavernous sinus. Through emissary veins the cavernous sinus communicates with the pterygoid plexus and by the carotid plexus with the internal jugular vein. Posteriorly, it gives off the superior and inferior petrosal sinuses. The superior petrosal sinus runs in the attached margin of the tentorium cerebelli above the trigeminal nerve and empties into the lateral sinus. The inferior petrosal

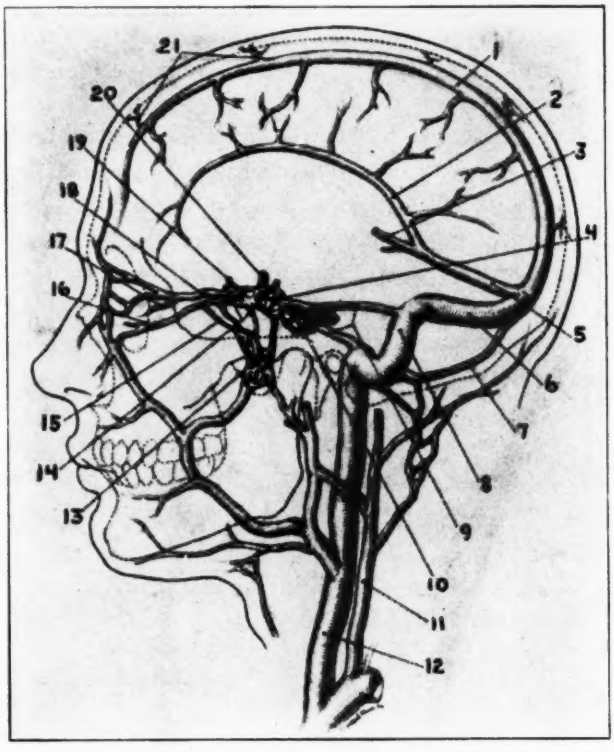

Fig. 1.—Drawing prepared by Dr. Frank R. Ford showing *1*, superior longitudinal sinus; *2*, inferior longitudinal sinus; *3*, vein of Galen; *4*, cavernous sinus; *5*, straight sinus; *6*, lateral sinus; *7*, occipital sinus; *8*, sigmoid sinus; *9*, superior and inferior petrosal sinuses; *10*, basilar sinus; *11*, external jugular vein; *12*, internal jugular vein; *13*, pterygoid plexus; *14*, intercavernous sinuses; *15*, communication between inferior ophthalmic vein and pterygoid plexus; *16*, inferior ophthalmic vein; *17*, central vein of retina; *18*, superior ophthalmic vein; *19*, sphenoparietal sinus; *20*, middle cerebral vein, and *21*, cerebral veins.

sinus, shorter but larger than the superior, passes with the sixth nerve below the petrosphenoid ligament and enters the internal jugular vein. Each cavernous sinus communicates with its fellow of the opposite side through the anterior and posterior intercavernous sinuses.

The superior longitudinal sinus commences at the foramen caecum and extends posteriorly in the attached margin of the falx cerebri to the internal occipital protuberance, where it usually turns to the right as the right lateral sinus. The superior longitudinal sinus receives four main tributaries: the frontal, precentral, postcentral and occipital veins. It drains the greater part of the external and the superior mesial surface of the cerebral cortex.

The inferior longitudinal sinus occupies the free margin of the falx cerebri. It is continuous with the straight sinus, which usually turns to the left and is continued as the left lateral sinus. The inferior longitudinal sinus receives blood from the mesial surface of the cerebral cortex.

The great cerebral vein (vein of Galen) drains into the straight sinus. It drains the greater part of the white matter and the basal nuclei.

The lateral sinus on each side commences at the internal occipital protuberance and runs laterally in the border of the tentorium to the base of the petrous bone, where it leaves the tentorium and passes down through the jugular foramen as the internal jugular vein.

The venous sinuses near the torcular show many variations. Five types may be described: (1) the common pool, which is pictured in most textbooks, (2) the plexiform, in which there may be an adequate cross-circulation between the two lateral sinuses, (3) the ipsilateral, in which a separate cross-channel from one lateral sinus to the other may be present and thus provide cross-circulation, (4) the unilateral, in which the straight and superior longitudinal sinuses empty into the lateral sinus of one side, and (5) the occipital, in which the occipital sinus may be of sufficient size to transport a large volume of blood.

SEPTIC THROMOBOPHLEBITIS OF THE CAVERNOUS AND LATERAL SINUSES

The following observations, except when otherwise stated, are based on clinical and autopsy studies of patients in the Johns Hopkins Hospital. The histories and autopsy records are summarized at the end of the section.

Thrombophlebitis of the cavernous sinus was observed at autopsy in all these cases. The following were the salient clinical findings.

Exophthalmos and Chemosis.—Exophthalmos was usually bilateral but might be unilateral (case 6). In a case reported by Keegan and Ash[4] it was absent. The amount of chemosis appeared to parallel the amount of exophthalmos.

4. Keegan, J. J., and Ash, W. E.: Bilateral Cavernous Sinus Thromboses Without Involvement of the Ophthalmic Vein: Report of Cases, Arch. Ophth. **12**: 72 (July) 1934.

Exophthalmos appeared to be mainly dependent on infection of the orbital tissues. Such a finding was present in all the cases reported here. Uhthoff expressed the belief that if infection does not proceed forward from the cavernous sinus, resulting in infection of the orbit, exophthalmos does not appear. Vascular obstruction, however, must play a part, since exophthalmos occurs in nonseptic thrombosis, and otherwise partial recession of a proptosed eye in a fatal case, such as was noted in case 6, would not occur.

The degree of exophthalmos was variable. It was less marked when the cavernous sinus was involved through a retrograde extension from the lateral sinus than when it originated from an anterior infection. Eagleton [5] referred to these cases as instances of a "chronic compensatory" type and remarked that in them the exophthalmos might be transitory.

Macewen stated that coincident with the involvement of the second eye there may be apparent improvement of the condition of the first eye.

Edema of the Lids.—This was a striking feature in cases of fulminating thrombosis, in which the thrombosis usually arises from an anterior infection. The upper lid was affected to a greater degree than the lower lid. The swelling of the lid may interfere mechanically with motion of the lid, so that paralysis of the levator may pass unnoticed. The lids are freely supplied with lymphatics. It appears that infection rather than vascular obstruction accounts for swelling of the lids. Faulkner [6] has shown that swelling of the lower lids is not pathognomonic of thrombosis of the cavernous sinus and may be due to infection of the antrum or the ethmoid sinus.

Paralysis of the Muscle of the Eye.—In cases of fulminating thrombosis there was early paralysis of the extra-ocular muscles on the affected side. Ptosis came on early. Behr,[7] among others, noted that it might be purely mechanical and that external ophthalmoplegia might be simulated by edema of the lids. He expressed the opinion that ophthalmoplegia is due to a lesion of the nerves in the cavernous sinus, caused either by pressure or by inflammation. It seemed impossible to establish either infection or pressure in the orbit or in the sinus as a single cause of muscle palsies.

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5. Eagleton, Wells P.: Cavernous Sinus Thrombophlebitis and Allied Septic and Traumatic Lesions of the Basal Venous Sinuses: A Clinical Study of Blood Stream Infection, New York, The Macmillan Company, 1926.

6. Faulkner, E. Ross: Surg., Gynec & Obst. **52**:474, 1931.

7. Behr, Carl, in Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 6, p. 229.

Internal ophthalmoplegia was rarely encountered at the first examination and was noted only once in this group of cases (case 1). It is usually described as a late symptom.

Parsons [8] has stated that paralysis of the external rectus muscle of the second eye is the first sign of its involvement. Such paralysis is probably to be explained either by basilar meningitis or by increased intracranial pressure.

In thrombosis of the lateral sinus the onset of paresis of the sixth nerve frequently signifies an extension forward of the process via the inferior petrosal sinus, which is the usual route by which the thrombotic process extends from the lateral to the cavernous sinus (cases 2 and 5). The involvement of the sixth nerve may be accompanied with pain in the face and behind the eye on the same side, due to involvement of the fifth nerve.

Transient improvement of external ophthalmoplegia was an unusual observation in case 6, in which there was also partial recession of the proptosed eye. The causal mechanism of this occurrence was not obvious. Conjugate deviation is unusual and was not observed in the cases reported here.

Some of these patients were so ill that cooperation could not be obtained in estimating the presence or absence of muscle palsies. In one such instance irrigation of the aural canals was a useful maneuver (case 5) when appropriate nystagmus indicated the absence of complete paralysis.

Nystagmus.—Nystagmus is infrequent and was not noted in the cases reported here.

Corneal Changes.—Increased corneal sensitivity was observed (case 5), but it soon gave way to anesthesia of the cornea. Cloudiness and necrosis of the cornea may be observed when there is exposure of the cornea, but frequently no change is seen.

Ophthalmoscopic Signs.—The ophthalmoscopic signs of thrombosis of the cavernous sinus are of slight importance in establishing the diagnosis. These signs are engorgement of the veins and low grade papilledema. The fundi, however, may remain normal throughout the course of the disease (Parsons). This appeared to be so in case 5 reported here. However, the eyes were not examined on the day preceding death and at autopsy showed low grade papilledema. Benedict [9] observed these signs in all his cases but remarked on their late appear-

8. Parsons, J. Herbert: The Pathology of the Eye, New York, G. P. Putnam's Sons, 1908, vol. 4, p. 1226.

9. Benedict, W. L.: Surg., Gynec. & Obst. **52**:262, 1931.

ance. Microscopic examination of the eyes in the cases reported here supported the view that papilledema is present in every case.

Generalized retinal edema may be apparent. This was observed in one case in the group reported here (case 4). Sections of the eye in this case did not differ from those in the remaining cases, in all of which there was retinal edema.

Pulsation of the retinal arteries was observed in one patient (case 1). This was due to pressure from swollen lids and orbital structures.

Hemorrhages are infrequent, and consequently, it may be inferred that thrombosis of the central vein is infrequent. Hemorrhages were not observed in the cases reported here.

Abscess formation in the eye apparently does not occur, although examination of the choroid always shows many cells, mostly mononuclears and lymphocytes and a few polymorphonuclears and leukocytes.

Visual Acuity.—It is usually impossible to chart the vision with any accuracy. It is frequently greatly reduced. In the cases reported here accurate records of visual acuity were not available.

Visual Fields.—There is nothing characteristic about the visual fields. In the cases reported here records of the visual fields were not attempted.

REPORT OF CASES

The summaries of the clinical histories and autopsy notes contain only the essential facts.

CASE 1.—E. C., a Negro woman aged 27, acquired a sore throat ten days before her admission to the Johns Hopkins Hospital. Three days after her throat became sore the left side of her face swelled, and a few days later the right side of her face swelled. The swelling on the left side receded. She had been extremely ill for several days prior to admission.

The temperature was 105 F., the pulse rate 142 and the respiratory rate 40. The patient was irrational. Her neck was stiff, and there was a positive Kernig sign on the right. The right side of her face was greatly swollen. She was unable to open her mouth. The lids of the right eye were edematous and greatly swollen, and folds of edematous conjunctiva protruded between them. The left upper lid was swollen. There was total ophthalmoplegia on the right and paralysis of all the extra-ocular muscles on the left, except the internal rectus muscle, which was partially paralyzed. The right eye was definitely proptosed, and the left eye possibly was slightly proptosed. There was venous congestion of the retina, more apparent on the right. The tonsils were reddened and swollen, but there was no evidence of peritonsillar or retropharyngeal abscess. The glands on the right side of the neck were swollen and tender.

The white cell count of the blood was 30,000. The spinal fluid contained 4,000 cells per cubic millimeter, mostly polymorphonuclears. Organisms could not be cultured from the spinal fluid. Blood cultures were negative.

The patient died on the second day after admission.

Autopsy.—There was abscess formation in each orbit. A purulent exudate extended over the surface of the brain, particularly over the base. There was a hemorrhage over the right frontal lobe. The cavernous sinuses were filled with

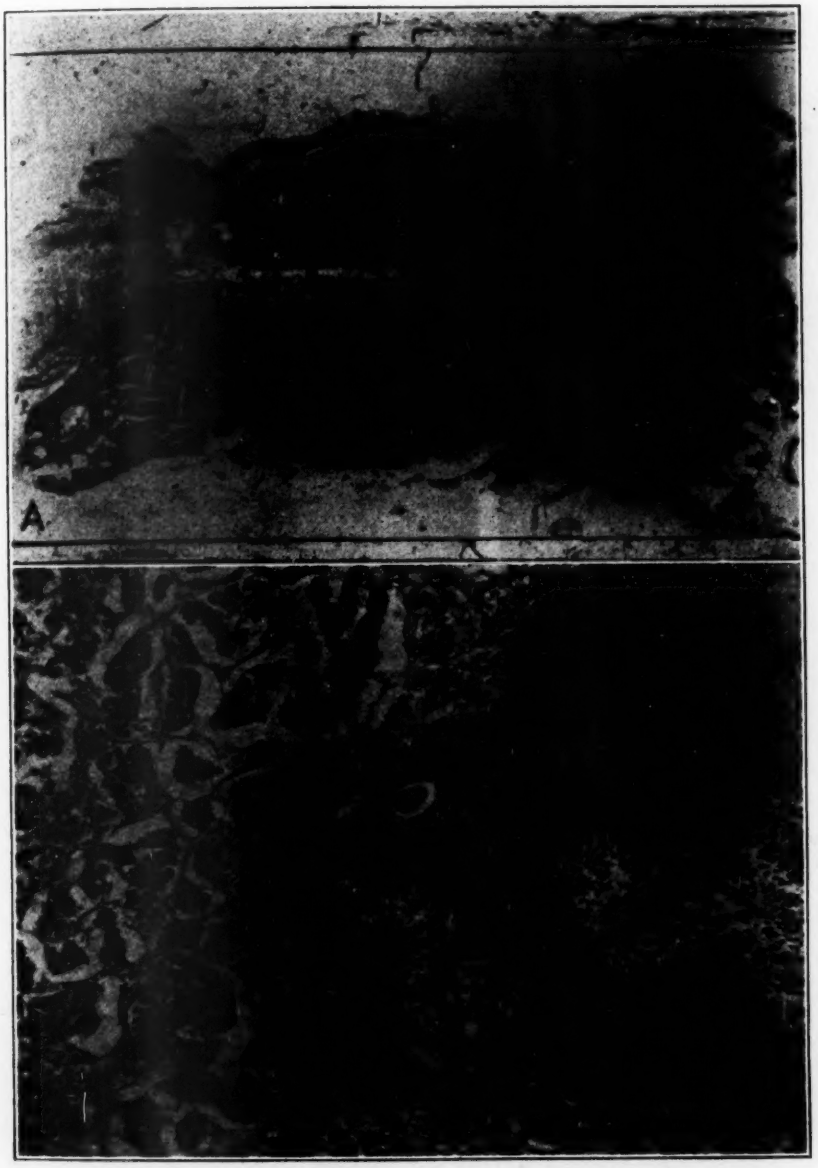

Fig. 2.—Sections from the hypophysis showing (*A*) general involvement and (*B*) necrosis and early abscess formation.

purulent material. The hypophysis contained an area of necrosis about the center of the anterior lobe, in which bacteria were present. The area was surrounded by inflammatory cells, many of which were polymorphonuclears. Pus was observed

extending along the floor of the sella turcica. The lateral and superior longitudinal sinuses were clear.

Bacterial stains showed gram-positive cocci in the hypophysis, cavernous sinuses, sphenoid sinuses and meninges.

CASE 2.—C. M., a Negro boy 7 years old, had a cold two weeks before admission to the hospital. A week after the onset of the cold, his left ear became painful and he complained of pain in the left side of his face. A paracentesis of the left ear drum failed to relieve the pain.

On the day of admission the temperature was 104 F., the pulse rate 124 and the respiratory rate 28. The head was turned to the right. There was tenderness over the tip of the left mastoid process. The left external rectus muscle was incompletely paralyzed. There were no other ocular signs. Other examinations, including the usual laboratory tests, failed to add anything to the clinical picture.

On the day after admission a simple mastoidectomy was performed on the left side. The mastoid antrum was opened and was found to contain pus, but there did not appear to be any extension of the process. There was no improvement in the patient's general condition, and consequently the wound was opened and the lateral sinus was examined. It did not appear to be thrombosed. Six days after admission the upper lid of the left eye became swollen and the neck became stiff. Within a day there was complete ophthalmoplegia on the left, and after another day the right eye was similarly affected. There was no ophthalmoscopic evidence of vascular obstruction until two days before his death, when there was slight venous overfilling.

Death occurred nine days after the boy's admission to the hospital.

Autopsy.—There was abscess formation in both orbits and purulent thrombophlebitis of both cavernous sinuses and of the left petrosal sinus. There was a subdural abscess on the left side and localized pachymeningitis and leptomeningitis. Layers of infected blood clots were present in the left middle cranial fossa, in the sphenoid sinus on the left and in the superior longitudinal sinus. The lateral sinus was patent on both sides. The torcular herophili was patent. An abscess 1 cm. in diameter was continuous with the left cavernous sinus. The nerves in the left sinus were invaded by inflammatory cells. One section of the carotid artery showed pus in its lumen. There was necrosis of a portion of the anterior lobe of the hypophysis.

The origin of this widespread thrombophlebitis is not clear. The fact that the clinical symptoms suggested involvement of the inferior petrosal sinus on the left and that pus was found in the mastoid antrum makes it appear probable that it originated in the lateral sinus.

CASE 3.—J. J., a Negro aged 41, was admitted to the Johns Hopkins Hospital complaining of a swollen left ear. He had had a chancre twenty years before and also a discharging left ear. Ten days before admission he caught cold, and on the following day there was an increased amount of discharge from the left ear, which had discharged irregularly for many years. Two days before admission the lids of the left eye swelled and he suffered from headache and chills.

On examination his temperature was found to be 101.4 F. and the pulse rate 100. There was marked boggy edema of the lids of the left eye. There were inability to move the left eye up or down and almost complete loss of lateral movement; the right eye moved normally. The pupils reacted normally to light. There was slight engorgement of the veins of the left eye. There were palpably

enlarged, tender glands on the left side of the neck. There was a thick, creamy discharge from the left ear, but no tenderness of the mastoid.

General examination showed an infection of the upper respiratory tract. Laboratory and roentgen examinations failed to add to the clinical picture.

Two days later there was definite involvement of the right eye. Both eyes became slightly proptosed and showed external ophthalmoplegia. There was slight clouding of the cornea. Ophthalmoscopic examination revealed slight evidence of venous engorgement and possible slight papilledema.

Death from septicemia occurred four days after the patient's admission.

Autopsy.—Both orbits were invaded by inflammatory cells, and the right cavernous sinus was thrombosed, with the thrombus extending into the left cavernous sinus. At the base of the sphenoid on the left the dura was separated

Fig. 3.—Areas of necrosis in the anterior lobe of the hypophysis.

from the bone by a soft bulging mass. The hypophysis showed microscopic evidence of necrosis of the anterior lobe, and although there was no gross evidence of meningitis, microscopic examination showed the presence of an inflammatory exudate in the meninges. Some of the veins surrounding the left carotid artery were thrombosed. The left mastoid process was eburnated from long-standing infection. There was an inflammatory membrane in the pharynx. Gram-positive cocci were found throughout the infected areas. This infection probably originated in the throat and spread to the cavernous sinus via the carotid venous plexus.

Case 4.—C. S., a Negro aged 40, suffered from toothache for ten days before admission to the hospital. This resulted in swelling of the left side of the face and inability to open his mouth. Two days before admission the lids of the left eye swelled, and a day later those of the right eye also. He had felt feverish for several days prior to admission.

Examination showed bilateral swelling of the lids, which could not be opened voluntarily. There were bilateral paralysis of the external rectus muscle and limitation of the movements obtained through the other muscles. The pupils reacted promptly to light. The corneas appeared normal, but there was increased sensitivity on the right. Ophthalmoscopic examination showed slight edema of the whole retina in each eye. There was a low grade papilledema. The left side of the face was greatly swollen. Difficulty was experienced in examining the mouth. Several teeth in the left side of the upper jaw were bathed in pus. General examination and the usual laboratory tests did not add anything to the clinical picture.

The swelling of the lids rapidly increased. The external ophthalmoplegia became complete. There was no appreciable change in the ophthalmoscopic appearance of the fundi.

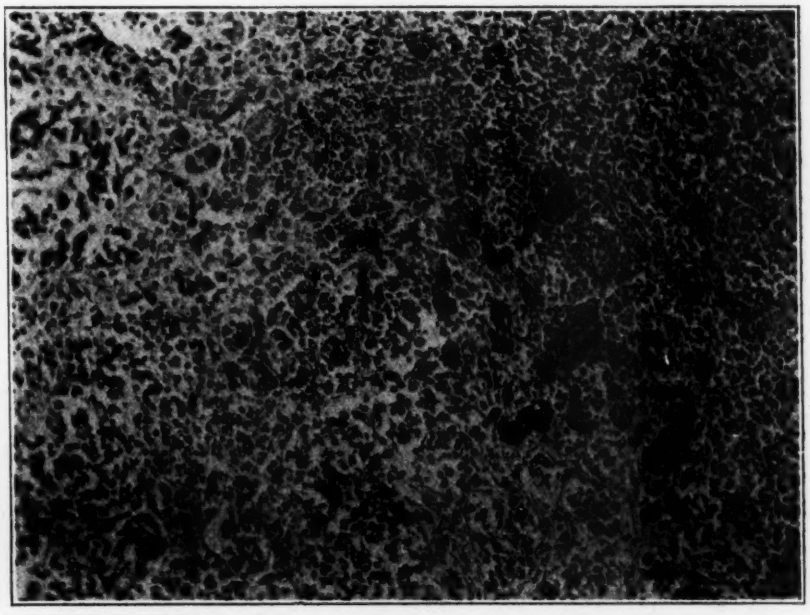

Fig. 4.—Areas of necrosis in the hypophysis.

Autopsy.—There were infected thrombi in the veins in each orbit and orbital infection. There were bilateral thrombosis of the cavernous sinus, acute osteomyelitis of the left sphenoid and left temporal bone and localized pachymeningitis and leptomeningitis on the left, with extension to the left temporal lobe. The dura on either side of the body of the sphenoid on its posterior surface was reddened, necrotic and overlying purulent material. There were multiple areas of necrosis in the hypophysis. Inflammatory cells were seen in the gasserian ganglion.

An interesting feature was the absence of meningitis. The infection appeared to have originated in the jaw and spread to the left orbit through the veins of the face and to have more directly infected the cavernous sinus through the pterygoid plexus. Infection of the cavernous sinus may have been via the sphenoid sinus.

CASE 5.—M. L., a white girl aged 2 years, was admitted to the hospital with a diagnosis of acute mastoiditis on the right, and questionable mastoiditis on the left. A simple mastoid operation was performed on the right, but it was not followed by improvement in the general condition. Three days later operation was performed on the other side. The condition became critical, and on the day after the last operation a positive Queckenstedt reaction was obtained on the left. The left internal jugular vein was tied off. One day later there was swelling of the lids of the left eye and of the left side of the face. At that time there were no extra-ocular palsies. The eyegrounds appeared to be normal except for a slight and questionable edema around the right disk.

Two days later there were great swelling of the lids of the left eye and slight swelling of those of the right eye. The left eye was slightly proptosed. There

Fig. 5.—Inflammatory cells in the gasserian ganglion.

was no change in the appearance of the fundi. The pupils were semidilated and reacted actively to light. There was apparent bilateral external ophthalmoplegia.

Irrigation of the aural canals with water, either hot or cold, produced appropriate nystagmus. These responses disappeared after twenty-four hours.

Death occurred nine days after the patient's admission to the hospital.

Autopsy.—There were abscesses in each orbit and a purulent exudate beneath the periosteum in the region of the frontoparietal suture on the left side. Either the middle meningeal vein or the artery was thrombosed. Both cavernous sinuses contained purulent material and were bathed in pus. Both lateral sinuses contained infected clots. The thrombus was small and gray in the right lateral sinus and a fresher red-gray in the left lateral sinus. The superior longitudinal sinuses and the straight sinuses were patent. An abnormality was noted in that a communicating branch between the right superior petrosal sinus and the middle

meningeal vein was present. The dura was loosened from the skull over the petrous portion of the left temporal bone and over the left sphenoid at the base. There were an abscess of the hypophysis and necrosis of the sphenoid.

In this case there was a bilateral infection of the lateral sinuses, which appeared to have spread forward to the cavernous sinuses and thence to the orbits.

CASE 6.—L. L., a white boy aged 15, was admitted to the hospital on March 18, 1936. He complained of pain in the right ear, discharge from that ear, frontal headache, recurrent chills and pains in the joints. He had had a discharging ear for over a year prior to his admission. One week before admission he had received tetanus antitoxin for an accidental burn. Ten days before admission he went swimming. This resulted in increased discharge from the ear. After a few days the ear became painful. He visited the dispensary on several occasions. There was no evidence of involvement of the mastoid. On March 18 he complained of severe frontal headache and of chills on the previous night.

The temperature was 103.4 F. and the pulse rate 106. There were tenderness of the right wrist and elbow, redness and swelling about the site of injection of the tetanus antitoxin and swelling of the glands in the right axilla. There was a copious discharge from the right ear. The eyes were normal on external examination. The vision was not tested. There was definite blurring of both disk margins, more marked on the right. The leukocyte count was 14,400. He was thought to be suffering from serum sickness, but because of the discharging ear and ophthalmoscopic signs he was admitted to the wards.

On March 20 a radical mastoidectomy was performed on the right. The lateral sinus was thrombosed. The sinus was opened, the clot evacuated and the sinus packed. The internal jugular vein was ligated. On the following day and for several days the patient felt better, but there was a continuation of the septic fever. On the sixth postoperative day he complained of a sense of fulness about his eyes. There were definite edema of the upper lid of the right eye and inability to elevate it normally, which appeared to be due to involvement of the nerves. There was a proptosis of 4 mm. The left eye appeared to be normal. The vision in each eye was acute. Ophthalmoscopic examination showed a bilateral papilledema, more marked in the right eye but not of sufficient amount to measure accurately. There was slight chemosis. On the seventh postoperative day there were complete paralysis of the external rectus muscle on the right side and inability to move the eye fully in any direction. On the following day the right eye could be moved in any direction almost normally and could be abducted fully, but the ptosis remained unchanged. There was at that time no change in the appearance of the fundi.

The packs were removed, and a quantity of foul-smelling pus was allowed to escape.

On the ninth postoperative day the patient became irrational, and swelling on the left side of the scalp was observed. On the next day there were a return of the paralysis of the right external rectus muscle and an almost complete paralysis of the other extra-ocular muscles of the right eye, and paralysis of the left external rectus muscle appeared. The amount of proptosis of the right eye was decreased definitely. There was no change in the appearance of the fundi.

Autopsy.—There was mastoiditis on the right, with erosion of the temporal bone. The right orbit showed abscess formation. The cavernous sinuses were filled with pus. The right transverse, inferior and superior petrosal sinuses were thrombosed. There was an abscess of the left temporal lobe. Meningitis was present.

COMMENT

Changes Observed at Autopsy.—In the cases reported here the changes observed at autopsy may be summarized as follows:

Orbits: In every instance infection of the orbital tissues was present. Infiltration of the muscles with inflammatory cells was frequent, as was thrombosis of the orbital veins.

Cornea: Clouding and necrosis of the cornea were observed clinically, but only posterior sections of the eyes were obtained for study.

Retina: Edema of the retina was present in all cases. It is notable that it was not more marked in the instance in which it was observed ophthalmoscopically than in the cases in which it was not observed. It probably appears late in most cases.

Choroid: Inflammatory cells were present in the choroid in all cases. These were mostly mononuclears and lymphocytes, with only a few polymorphonuclear leukocytes. In no case was there abscess formation in the eye.

Optic Disks: Low grade papilledema was present in all cases. Thrombosis of the central retinal vein was not observed.

Nerves: Inflammatory changes were noted in the nerves in one instance and in the gasserian ganglion in another.

Cavernous Sinuses: Owing to the tendency for septic thrombi to disintegrate and liquefy early, microscopic examination may be essential in the pathologic diagnosis of thrombophlebitis of the cavernous sinus.

Hypophysis: This structure was affected in five of six cases. The stalk of the hypophysis appeared normal in the one instance in which it was examined. Necrosis with or without inflammatory cells is the usual lesion. This probably arises through infarction, which, however, would be difficult to demonstrate, as it would necessitate cutting serial sections.

Involvement of the hypophysis has not been stressed in previous reports on septic thrombophlebitis of the cavernous sinus. In those instances in which a clinical diagnosis of cavernous sinus thrombosis is made it is usually only of academic interest, but in cases in which recovery takes place signs of hypophysial dysfunction may occur.

It is probable that thrombosis of the cavernous sinus with recovery is relatively frequent, for the diagnosis is made only when ocular signs are present, and it is fairly frequently noted unexpectedly at autopsy.

I wish to present the essential facts regarding a case in which thrombosis of the lateral sinus ultimately resulted in Fröhlich's syndrome and extreme loss of vision.

K. C. P., a white boy of 11 years, entered the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital on Aug. 2, 1933. He complained of blind-

ness of the right eye and marked loss of vision of the left eye. The family history was irrelevant. He had had abscesses in the ears as a small child.

Present Illness.—The patient's mother dated the onset of his present illness from the occurrence of mastoiditis on the right side two years before the date of the admission. The symptoms of mastoiditis were present for two weeks before operation was performed. Operation was followed by a stormy course, and ten days later the jugular vein was ligated. Tonic deviation of the eyes to the right was noted after this operation. Five days later polyuria and polydipsia developed, which persisted for six or eight weeks. His recovery was further complicated by phlebitis of the right leg and an infection of the hip joint. He gradually lost vision in both eyes. After the acute signs had subsided, there was no light perception in the right eye and the vision in the left eye was 3/200. The optic disks were reported to be swollen and to have connective tissue about them.

Examination.—The boy presented the characteristic signs of Fröhlich's syndrome. General and neurologic examinations gave negative results. Otologic examination showed the hearing in the right ear to be abnormally acute.

General, laboratory and roentgen examinations gave negative results.

Examination of the eyes showed them to be normal externally. The pupil of the right eye did not react directly to light. The vision in the left eye was 6/200. There was bilateral secondary atrophy of the optic nerve.

My interpretation of the sequence of events in this case is otitis media followed by thrombosis of the lateral sinus; extension of the thrombotic process, accounting for the conjugate deviation of the eyes; extension to the cavernous sinus and surrounding structures, resulting in increased intracranial pressure and the symptoms of diabetes insipidus; and, finally, through necrosis of the hypophysis, the development of Fröhlich's syndrome.

THROMBOSIS OF THE LONGITUDINAL SINUS

The primary form usually commences in the middle fifth of the superior longitudinal sinus (Byers and Hass [10]). The high position of the sinus, low pressure, slow current and the presence of pacchionian bodies predispose to it (Wohlwill [11]). It occurs usually in debilitated infants and as a result of actual changes in the blood itself, notably in chlorosis. If the obstruction of the sinus is considerable, it leads to hemorrhagic extravasations into the cerebral cortex, with subsequent softening, increased intracranial pressure and blood in the spinal fluid.

Some of these patients have symptoms indicative of cortical irritation. Jacksonian convulsions occur frequently. As the superior external surface of the cortex in the motor region for the lower limbs is involved, symptoms of involvement of the pyramidal tract confined to

10. Byers, R. K., and Hass, G. M.: Thrombosis of Dural Venous Sinuses in Infancy and in Childhood, Am. J. Dis. Child. **45**:1161 (June) 1933.

11. Wohlwill, Friedrich, in Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 6, p. 17.

the lower limbs may be present (Holmes and Sargent [12]). Papilledema and engorgement of the vessels of the scalp, retina and conjunctiva occur, but, on the other hand, there may be a complete absence of signs when subsequent autopsy observations make it difficult to understand their absence. Conjugate deviations of the eyes occur often. Exophthalmos and optic neuritis have been reported rarely. Uhthoff referred to Good's case of cortical blindness.

When the thrombotic process is septic and has extended to the longitudinal sinus from the lateral sinus, the prognosis for life is poor. Doyle [13] in describing this type concluded: (1) In the absence of meningitis, early apathy or stupor in a patient with evidence of thrombosis of the transverse sinus secondary to otitis media indicates infectious thrombosis of the superior longitudinal sinus by retrograde extension, especially if associated with choked disks or convulsions; (2) when tumor or inflammatory disease can be excluded, jacksonian seizures showing progression from one foot to the other or beginning in the foot and gradually involving the homolateral upper extremity suggest impairment of the circulation of the cerebral veins and probably thrombosis of the superior longitudinal sinus, and (3) abrupt onset of symptoms of increased intracranial pressure with fluctuations suggests thrombosis of the superior longitudinal sinus as well as ventricular tumor. The absence of the element of progression after a fair length of time or actual regression of symptoms is suggestive of thrombosis of the superior longitudinal sinus. If the syndrome is associated with edema of the lids and dilatation of the veins of the eyelids and forehead, and if fracture of the skull, orbital and periosteal infections and thrombosis of the cavernous sinus can be excluded, the diagnosis is established.

PAPILLEDEMA IN THROMBOSIS OF THE LATERAL SINUS

Bilateral papilledema occurs frequently in thrombosis of the lateral sinuses and does not necessarily indicate a poor prognosis. Dill and Crowe [14] observed it in twelve of their thirty cases of thrombosis of the lateral sinuses. In ten patients the papilledema was bilateral, and in two it was unilateral. They attributed its bilateral occurrence to increased intracranial pressure and its unilateral occurrence to involvement of the cavernous sinus.

Benedict has stated that bilateral papilledema in these cases signifies increased intracranial pressure but does not indicate its cause. Abscess

12. Holmes, C., and Sargent, P.: Brit. M. J. **2**:493, 1915.

13. Doyle, John B.: Obstruction of the Longitudinal Sinus, Arch. Neurol. & Psychiat. **18**:374 (Sept.) 1927.

14. Dill, J. Lewis, and Crowe, S. J.: Thrombosis of Sigmoid or Lateral Sinus: Report of Thirty Cases, Arch. Surg. **29**:705 (Nov.) 1934.

of the brain and meningitis are frequent causes. In other cases it has been assumed that the papilledema is due to "serous" or "protective" meningitis or to "otitic hydrocephalus." These descriptive titles have not had a satisfactory anatomic and pathologic basis. It is in this connection that Woodhall's [15] recent work is of interest.

RECENT INVESTIGATIONS

The investigations carried out by Dr. Barnes Woodhall had to do with the relationship between increased intracranial pressure and thrombosis of the intracranial venous sinuses. The work is valuable in that it appears to establish a reasonable explanation for the occurrence of bilateral papilledema in cases of lateral sinus thrombosis and tends to indicate that in certain cases so-called serous meningitis may result from thrombosis of the dural sinuses.

Previous investigators have established wide variations in the pattern of the intracranial venous sinuses. These variations occur most frequently in the region of the torcular and have already been described. Woodhall, by examining two hundred autopsy specimens, has confirmed previous observations. Reports in the literature indicate that these variations are of importance. Among others Linser,[16] Kummer [17] and Eagleton [18] have reported cases in which at autopsy thrombosis was found to be associated with abnormalities of the unaffected sinuses. Bilateral sinus thrombosis or unilateral sinus thrombosis, when a great disparity in the size of the lateral sinuses exists, has been observed to result in increased intracranial pressure. Recently, abnormalities of the sinuses have been reported as responsible for negative or false positive readings in the Tobey-Ayer modification of the Queckenstedt test as employed in the diagnosis of thrombosis of the lateral sinuses. These clinical observations, verified by the occurrence of similar cases during the period of these investigations, have led to the conclusion that inadequate venous drainage results in increased pressure. Ordinarily the lateral sinus of the opposite side can take care of the extra volume of blood when one lateral sinus is thrombosed, but if there is not an adequate cross-circulation or if the unobstructed lateral sinus is small there is resultant back pressure and consequently an increased intracranial pressure. It is suggested by Woodhall that this is the anatomic basis

15. Woodhall, Barnes: Variations of the Cranial Venous Sinuses in the Region of the Torcular Herophili, Arch. Surg. **33**:297 (Aug.) 1936. Woodhall, B., and Seeds, A. E.: Cranial Venous Sinuses, Correlation Between Skull Markings and Roentgenograms of the Occipital Bone, ibid. **33**:867 (Nov.) 1936.

16. Linser, P.: Beitr. z. klin. Chir. **28**:642, 1900.

17. Kummer, E.: Rev. de chir. **19**:531, 1899.

18. Eagleton, Wells P.: Arch. Otol. **25**:91, 1906.

for bilateral papilledema as observed in acute thrombosis of the lateral sinus and also in certain cases described as instances of serous meningitis when there is a history of an otitic infection and a sinus block can be demonstrated.

In addition to the verification of previous observations and correlation of them clinically, a technic for obtaining roentgenograms of the occipital bone enabling estimation of the size of the lateral sinuses has been worked out.

CONCLUSIONS

The ocular signs of thrombosis of the cavernous, lateral and superior longitudinal sinuses are briefly reviewed.

Necrosis of the hypophysis was noted in five of the six cases reported. An additional report illustrated the possibility of hypophysial involvement through thrombosis of the lateral sinus.

Recent work is briefly summarized. It appears to supply an anatomicopathologic basis for the occurrence of bilateral papilledema in thrombosis of the lateral sinus and in certain cases of so-called serous meningitis. The work requires confirmation.

DISCUSSION

DR. THOMAS H. JOHNSON: The subject of thrombosis of the intracranial venous sinuses is an important one to the ophthalmologist. Early in the onset his opinion may be the deciding factor in the diagnosis. The society is fortunate in having the subject so ably presented by Dr. Walsh.

I have not observed any case of aseptic sinus thrombosis in which a diagnosis was made ante mortem. I shall limit my remarks to a discussion of septic thrombosis. In retrograde thrombosis the ocular symptoms are less severe and come on later than when the infection has been anterior. The explanation for this lies in the anatomy. The course of the infection in anterior thrombosis is along the ophthalmic veins, which traverse the orbit on their way to the cavernous sinus. The orbital tissues and cavernous sinus therefore become involved earlier in the anterior infections than in the retrograde infections.

In my experience swelling of the upper eyelid in orbital and intraocular infections has been more common than swelling of the lower lid and is very prevalent in such infections.

Exophthalmos is an important early sign, whether pus is present in the orbit or not. It is due to an orbital cellulitis; probably venous stasis is also a factor. In three of Dr. Walsh's cases there was an abscess in each orbit, and in one an abscess in the orbit on the side of the mastoid infection. There may be marked exophthalmos without the presence of pus. I have in mind two cases that I observed in consultation. One patient was a young woman who had squeezed a small pimple on the right upper eyelid. The next day she had exophthalmos on the right side, edema of the conjunctiva and a slight blurring of the margin of the disk. The exophthalmos rapidly increased, and an incision was made into the orbit through the upper and lower nasal fornices and drains inserted. I saw her on the follow-

ing day; the papilledema had increased, she had a high temperature and there was no drainage from the orbit. She died the next day. The other patient was a young medical student who, after having a tooth extracted, acquired unilateral exophthalmos with orbital cellulitis. There was slight papilledema on the involved side. Deep incisions in the orbit revealed no pus. The termination was fatal. There is slight doubt that the orbital cellulitis is a result of an infection and that if the patient should survive long enough pus would appear in the orbit.

The nerves that lie in the cavernous sinuses are exposed to toxins and pressure from the thrombus which lead to paralysis, but the edema in the orbital tissues is also a factor in producing complete ophthalmoplegia externa. When the lateral rectus muscle of the opposite eye is involved, I think that it is an indication that the process has extended to the other cavernous sinus or that intracranial pressure has developed. It is common in instances of tumor of the brain to see paresis of the lateral rectus muscle from intracranial pressure. Anesthesia of the cornea and the skin of the forehead and cheek may be produced by pressure in the cavernous sinuses on branches of the fifth nerve.

I do not agree with Dr. Walsh that ophthalmoscopic signs are of slight importance in making a diagnosis in thrombosis of the cavernous sinus. When present, edema of the head of the nerve is of great diagnostic importance. Manifest edema of the head of the nerve has been present in the early stages in most of the cases I have observed. When bilateral papilledema is present, I think that it indicates that the infectious process has extended to the lateral sinuses or has set up a serous meningitis or abscess of the brain with a concomitant intracranial pressure. The intracranial pressure may be due to inadequate venous drainage, complicating serous meningitis or abscess formation. Therefore, bilateral papilledema has important prognostic significance, as it indicates an extension of the process and intracranial complications, as does also paralysis of the contralateral sixth nerve. The edema of the intracranial tissues is probably analogous to that of the orbital cellulitis.

An early appearance and severity of the ocular symptoms probably indicate that the infection is anterior rather than retrograde.

DR. R. TOWNLEY PATON: It is indeed a pleasure to participate in the discussion of so interesting a subject as the ocular signs of thrombosis of the intracranial venous sinuses.

After reviewing the literature carefully, I find that there is little for me to add in criticism or as an explanatory note to the first portion of this paper. No mention is made of the pitfalls to be avoided in making a differential diagnosis and etiologic diagnosis of thrombosis of the intracranial venous sinuses. Most authors agree that malaria, typhoid, bronchopneumonia and erysipelas are often overlooked until late in the disease. Also in passing, I should like to mention the Crowe-Beck sign, which is little known to ophthalmologists but which has a definite clinical value. Crowe stated that "if in a normal person one internal jugular vein is compressed with the finger, no appreciable evidence of stasis is to be seen in the supra-orbital or retinal veins. If, however, both internal jugulars are compressed at the same time, a marked dilatation ensues. If the pressure is now released on one side, while it is maintained on the other, the engorged veins empty immediately. If, however, the jugular bulb is thrombosed on one side—say

the right—the veins will still remain engorged if the pressure is maintained on the left internal jugular, even though it is released on the right side." I should like to ask Dr. Walsh the value of this sign.

The second part of the paper, dealing with the autopsies and complete records of six cases, shows how carefully this subject has been studied. Dr. Walsh points out that the hypophysis is frequently involved—a point not emphasized by previous investigators.

Dr. Walsh made a statement that inadequate venous drainage results in increased pressure. I suppose that he is referring to increased intracranial pressure. No mention was made of the effect of intra-ocular pressure or whether the intra-ocular pressure was different in the cases of unilateral involvement. Lauber states: "All observations and experimental facts support the idea that increase of diastolic venous pressure in the retina and its relation to the diastolic arterial pressure in the retina are decisive for the formation of papilledema. If the arterial tension in the retina is low, even a slight increase of venous pressure caused by high intracranial pressure produces papilledema." It would seem, then, that so long as one does not know the intra-ocular pressure, as measured with a tonometer, one's interpretation of the underlying etiologic conditions may be wrong. This point then remains to be proved, but the inference of Dr. Walsh that in cases in which there is bilateral papilledema the condition is the result of a compensatory mechanism due to a congenital malformation of the lateral sinus is suggestive, and it is the first time that the clinical and pathologic investigations have been so thoroughly discussed.

DR. FRANK B. WALSH: Increased corneal sensitivity and corneal anesthesia in thrombosis of the cavernous sinus are due to involvement of the ophthalmic division of the fifth nerve. It has been suggested that pain in the face and behind the eye in petrositis may be due to involvement of the vidian rather than the fifth nerve. This seems unlikely, owing to the fact that the sphenopalatine ganglion supplies branches to the palate and to the nose, to which pain is not referred.

I do not wish to minimize the importance of ophthalmoscopic signs in thrombosis of the cavernous sinus, but I believe that considered singly they are of slight value in arriving at a diagnosis, as they usually occur late. Furthermore, bilateral or unilateral papilledema occurs frequently in thrombosis of the lateral sinus, when there are no other signs that would indicate involvement of the cavernous sinus.

The possibility of changes in the intra-ocular pressure has not been considered in this paper.

Woodhall's work seems to establish a definite basis for the occurrence of papilledema in thrombosis of the lateral sinus as well as for so-called serous meningitis when there is a history of otitis media and a sinus block can be demonstrated.

My attempts to demonstrate the Crowe-Beck sign have been unsuccessful.

I wish to thank Dr. Johnson and Dr. Paton for their discussion.

A SECOND GROUP OF CASES OF ARACHNODACTYLY

RALPH I. LLOYD, M.D.
BROOKLYN

Two years ago, at a meeting of this society, I reported six cases of arachnodactyly in two families. Through the courtesy of the surgeons of the Brooklyn Eye and Ear Hospital and their assistants, nine more cases will be added. The new cases have not explained the origin of the condition, but hereditary influences are more certain. Perhaps the best way to present this matter will be to describe the new cases and summarize briefly the points that they emphasize.

REPORT OF CASES

CASE 1.—David B., aged 15, from Dr. Place's clinic, had vision of counting fingers at 6 feet (1.8 meters), but by holding print close to an eye with a little study he could read ordinary print in a surprising manner. Both corneas were smaller than normal, but I did not measure them. The tension (according to the new Schiötz scale) was 18 mm. in one eye and 13 mm. in the other. The left lens was dislocated. It was hard to see the other lens, but it was probably dislocated also. This element of uncertainty was due to the fact that the pupils did not dilate, even after three days of treatment with a 1 per cent solution of atropine instilled twice daily. There was an opacity in each lens like a rider, from below, and one adhesion in the right eye at 7 o'clock, which was not explained by anything in the patient's history. In the pupillary area of each eye were remnants of pupilary membranes, and in the lenses beneath were numerous opacities. The adhesion was probably one of these remnants. The patient had curved little fingers, a depression in the midline of the lower part of the sternum and pulmonary stenosis (G. H. Roberts), which was evidently not serious. The height was 59 inches (1.5 meters), and the span, 68 inches (1.7 meters). He had three normal sisters, and the parents' eyes were normal (so the sister said), although the father was tall and thin. The parents and two sisters could not be induced to come to the clinic, but the sister who brought the patient was normal in every respect. Of course, the fundus could not be inspected, because of the small pupils; the miosis was the most stubborn of any I have seen. The transmitter of the condition was evidently the father, but as my associates and I have never seen him, the question remains open. The patient's skeletal changes were not extreme but were typical of arachnodactyly, and there was also pronounced lordosis. This patient showed some of the characteristics of status dysraphicus, such as curved little fingers, a depression in the sternum and lordosis, but the exaggerated span, the heterochromia and the syndrome of Horner were lacking. The patient was of German ancestry. The father was an uncle of the mother. The patient gave a negative

Read at the meeting of the American Ophthalmological Society, Hot Springs, Va., June 1, 1936.

Wassermann reaction. This is the only consanguineous marriage in the history of any of the patients I have seen; also, this patient is the only one of either group that I have studied with small corneas. Megalocorneas have been reported, but I have not seen any.

CASE 2.—Dr. Irving Jacobs had among his private patients a boy of 7 of Italian parentage. This patient was of the same general build as the patient in case 1 but would escape inclusion in this group but for his eyes. The father had congenital ptosis of the left upper lid, but the mother and another boy and one

Fig. 1 (case 1).—Photograph of the patient, showing typical arachnodactyly associated with congenital heart disease.

girl are normal. Vision was counting fingers at 5 feet (1.5 meters) in both eyes, and skiascopy showed 14 diopters of myopia. The pupils dilated well under the influence of atropine, and both lenses then appeared much smaller than normal, with a clear margin all around except above inward (fig. 2). Slit lamp examination made it plain that the anterior surfaces of the lenses were almost round. The lenses were not entirely clear. Owing to the reduced diameters, the impression that one received first was that the lenses were pushed back rather than displaced laterally. Visual acuity could be improved to 10/200. The fibers of the zonules were long and unbroken,

but the lenses were tremulous. Some months later the right lens was dislocated into the anterior chamber, with the characteristic symptoms that go with that condition. The upper pole of the lens was a little behind, and the lower pole somewhat in front of, the iris. The spherical outline of the lens was evident now more than ever. Vision was limited to perception of light, but projection was good. A strong beam of light was thrown on and into the eye by Dr. Jacobs, and the iris suddenly contracted and forced the lens back into the vitreous, but it came back into the anterior chamber when the patient sat up. Pilocarpine was used for the purpose of contracting the pupil behind the lens and holding it there to make extraction easier. But, as in the history of patients whose cases have been reported elsewhere, the tension rose to 45 (Schiötz), and pain and congestion were immediately aggravated. All the symptoms were relieved when the miotic was discontinued. The next day Dr. Jacobs removed the lens, which had the classic globular form to be expected when the fibers of the zonule are relaxed or broken, but it seemed entirely clear to the naked eye, as a normal lens should, which was a different finding from that indicated by the slit lamp examination. Prolapse of iris tissue into the wound required making a conjunctival

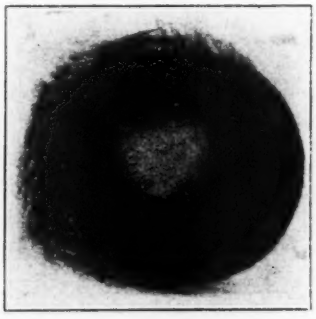

Fig. 2 (case 2).—Drawing of lens, showing the spherophakia of 14 diopters. The parents and two other children were normal.

flap a few days later, but recovery was complete, without any other complication. The lens was removed from the eye without difficulty, and there was no tendency for the lens to fall back into the vitreous. On recovery the patient accepted a +10.50 diopter sphere and a +2.25 diopter cylinder, axis 170, with resulting visual acuity of 20/50. The usual refractive value of the lens amounts to about 10 or 12 diopters, but in this case there was a difference of 25 diopters, indicating that the globular form of the lens, and not the lengthening of the eyeball, accounted for the myopia. My associates and I suspected that this patient was mentally defective. It might be mentioned in this connection that congenital dislocation of the lenses among patients with mental deficiency has been observed more frequently in Switzerland than elsewhere. The second lens was now more freely movable than it had been, and its complete dislocation was expected. (This paper was read early in June. Late in the same month the expected dislocation of the left lens into the anterior chamber occurred. No miotic was used, but the symptoms were easily controlled by atropine. The lens was easily removed and weighed 0.157 mg. It measured 7 mm. in both the vertical and the horizontal diameter, and from the anterior pole

to the posterior pole it measured 6 mm. At the anterior pole was a trace of the flattening found in the normal lens, and the lens seemed as clear to the naked eye as the first one removed.)

CASES 3 and 4.—A girl 9½ years old came from Dr. Ohly's clinic complaining of poor vision (fig. 3). Vision was improved to 20/70 with a + 10 diopter sphere +2 diopter cylinder, axis 105 for one eye and a +8 diopter sphere +2 diopter cylinder, axis 75 for the other. Both lenses were dislocated to such an extent that the pupillary areas were almost entirely freed. The right lens was displaced

Fig. 3 (case 3).—Photograph of the patient, showing typical arachnodactyly. The father was normal; the mother had mild ectopia lentis but none of the skeletal changes of arachnodactyly.

upward and outward, while the left was displaced almost directly upward. From the lower border of each lens broken strands of fibers of the suspensory ligaments waved freely. The patient showed typical arachnodactyly. The father and two children (aged 8 years and 2½ years, respectively) were normal. A 9 month old child required a very large shoe, but no other signs of the ailment could be found. Under the influence of atropine the patient's pupils opened about half the normal extent. The mother was plump and short and was pregnant at this time. The mother's eyes were of much interest, since the occurrence of incomplete syndromes

has been recognized. She wore a +5.50 diopter sphere +2.50 diopter cylinder, axis 90 for one eye and a +7 diopter sphere +0.50 diopter cylinder, axis 30 for the other, with visual acuity of 20/50 for three letters and 20/20 for three letters, respectively. Her pupils did not dilate well after the instillation of homatropine, but the right lens was dislocated upward and inward and the left lens was somewhat out of position. The right eye turned in when she was small and was operated on at the age of 19, with a good, but not a perfect, cosmetic result. In neither eye could margins of the lens be seen, but the dislocation was evident from the shadow seen at the bottom of the dilated pupillary area.

In the various families under observation a parent with dislocation of the lenses but a great deal of subcutaneous fat and no bony changes has had children with the complete syndrome, and a parent with normal eyes but pronounced bony changes and no subcutaneous fat has also produced children just as typically affected. From descriptions in the literature and from findings in the groups of cases reported my associates and I have come to regard congenital bilateral dislocation of the lens as a part of a syndrome which, when complete, is one of typical arachnodactyly, but either dislocation of the lens or the skeletal changes may be missing. There is no exact standard to enable one to distinguish the slight departures from the normal skeleton and musculature; there is no doubt that slight dislocations do escape detection, but any great departure in this respect would eventually be found, especially if there are other cases of ectopia lentis or suspicious skeletal changes in the preceding or following generations. The mother was considered to be the transmitter in this family, but it was impossible to obtain reliable information about the preceding generation.

CASES 5, 6, 7 and 8.—A girl of 7½ years from Dr. Ohly's clinic was brought to the hospital by her mother because of poor vision. This child had been very deaf from birth, and both lenses were displaced upward and inward. The lenses were clear on ophthalmoscopic examination, but slit lamp examination disclosed many fine dots and some haze. Vision with a —6.00 diopter sphere for one eye and a —5.00 diopter sphere for the other was 10/40—3 letters and 10/70, respectively. The department for patients with diseases of the ear found nothing to explain the deafness, and there was no history of illness in infancy to account for it. There was a small crescent of clear pupil in each eye, but the vision obtained was through the lens. The pupils dilated well; the long fibers of the suspensory ligaments were clean and free from deposits of pigment, and no ruptured strands were found. The irides trembled, but the lenses did not. The body showed the changes typical of arachnodactyly, and there was roughness of the pulmonary first sound. Divergent strabismus was present in the eye with the poorer vision. The older sister was reported as having had similar signs, including deafness, poor vision, delayed dentition (from ten to twelve months) and lateness in walking. She was also tall and thin, and a lantern slide shows the strong resemblance to the affected parent. This child was killed in an automobile accident. She wore a +7.75 diopter sphere for both eyes, but the clinical record gave no other details, as she was very young at the time of examination. The mother

was not affected and had normal vision with a —2.00 diopter sphere for one eye and a —3.00 diopter sphere for the other. The father was the transmitter, and he evidently derived the influence from his father, as figure 4 *C* shows. The father of the child wore a —4.00 diopter sphere for the right eye and a —2.00 diopter sphere —6.50 diopter cylinder, axis 120 for the left, with visual acuity of 5/200 and 20/33 (dif.) with this correction. The correction for the right eye was merely a "gesture," as it did not influence the vision at all, and there was so much astigmatism that it could not be measured. The right lens was displaced outward, and about half of the pupil was free from the lens. The left lens was

Fig. 4 (cases 5, 6, 7 and 8).—*A*, photograph of the older sister of J. K., deceased. *B*, photograph of J. K., showing typical arachnodactyly; vision with correction was 10/40 in one eye and 10/70 in the other. *C*, photograph of the father, also showing typical arachnodactyly, with his father beside him. The latter had not been examined.

displaced but little; it was rounder than the usual lens, and there were two notches in its border. The suspensory fibers were in good condition, very long and clearly seen, with dots of pigment adhering to them here and there, and there were numerous minute opacities scattered throughout the lenses. The patient showed typical arachnodactyly, and the photograph of his father, who also had a history of poor vision, indicates clearly the line along which the inherited disorder was transmitted.

In this connection it is interesting to note that none of the patients of the two groups have been blonds. Some were very dark skinned and the hair was very black, despite the light hair of the unaffected parent. None of the patients seen has been of English ancestry. One was of German origin; two families were Jewish, and the rest have been Italian.

The last case is the most remarkable.

Fig. 5 (case 9).—Photograph of the patient. The age was 14 years; the weight, 165 pounds; the height, 6 feet, 8½ inches; the span, 6 feet, 11½ inches, and the weight at birth, 10½ pounds.

CASE 9.—The patient was sent to me by Dr. Ohly from his private practice. The mother was not affected, but no satisfactory information about the father could be obtained. Inquiry into his physical make-up and character was skilfully deflected. The patient was 6 feet, 8½ inches (2.04 meters) tall at the age of 14 years, and he had a span of 6 feet, 11½ inches (2.1 meters). His body showed the changes typical of arachnodactyly, but physical examination and an electrocardiogram (G. H. Roberts) showed no abnormality. The Wassermann

reaction was + —, and there were bilateral reducible hernias of no importance. Because of his height, a roentgenogram of the skull was taken; the pituitary gland and the clinoid processes were normal. Dr. Rendich reported some indications of increased cerebral pressure. The weight was 165 pounds (74.6 Kg.). The weight at birth was 10½ pounds (4,762.7 Gm.). The pupils were very small and dilated little; the irides shook. The right eye showed much vitreous opacity, with many soft light-colored spots in the choroid and thinning between the choroidal vessels. The outlines of the disk were not clear; the disk seemed somewhat swollen, but the view was not good enough to enable one to be positive about these finer details, because of the small pupils and the hazy vitreous. The right lens could not be seen. The left lens was not clear, and its entire anterior surface was covered with a fine network of remnants of persistent pupillary membrane

Fig. 6 (case 9).—Photograph of the patient as an infant. Note the right thumb.

composed of triangular spots with fine tails running from the angles. The left lens was tipped far back, retaining an attachment below. No comment about the patient's body formation or lack of subcutaneous fat is necessary, as figure 5 shows the details. The slit lamp showed long strands of shreds of persistent pupillary membrane that floated backward and forward through the pupils (when these were dilated), especially in the left eye. They reminded one of a wisp of cotton moving in a draft that is too weak to affect any other thing. The movement of the shreds backward through the pupil into the vitreous and then forward through the pupil into the aqueous was the result of the pressure of the upper lid as it descended in winking and the release of this as the lid rose. The patient wore a size 11½ shoe, and his fingers, elbows and wrists could be bent back so far that the appearance was uncanny. The photograph of the patient as an infant (fig. 6) shows this feature in the thumb of the right hand. This abnormal flexi-

bility of the fingers may turn out to be a reliable early sign of the skeletal changes which can vary within such wide limits without attracting attention unless the vision is poor. The scapular angles were not everted, but the right shoulder drooped, and the right scapula was pushed backward. The patient's father and grandfather were said to have had poor eyes, but no other details of the histories of these ancestors could be learned. The abnormal height of this patient suggests pituitary hyperactivity, and other observers have reported their suspicions of a disorder of the pituitary gland, but no one seems to have found pituitary involvement.

Dr. L. G. Rowntree, of Philadelphia, has made experiments on animals with extracts of pineal and thymus gland and has speeded up the development of white rats in an amazing manner with injections of thymus extract, while pineal extract retarded development of the skeleton. This is a line of thought worth following, but it hardly seems possible to expect anything of any remedy in this patient at this age. Perhaps in a family in which there was a typical case of this condition in a parent, treatment along the line mentioned might aid normal body development of a young child or prevent or mitigate extreme clouding and displacement of the lens. In some cases the dislocation of the lenses seems to become steadily worse, and most of the dislocations into the anterior chamber have occurred in rather young patients.

COMMENT

Spherophakia and microphakia appear to be advanced phases of congenital dislocation of the lens, due to unusual and progressive laxity of the suspensory ligament. This permits the natural elasticity of the lens to produce an apparently small but almost globular lens. The vertical and horizontal diameters are necessarily reduced, and eventually dislocation of the lens into the anterior chamber follows. Assuming that congenital dislocation of the lenses is but a part of a syndrome and not an entity by itself, I have looked over the literature on cases of this condition reported during the past twenty years and have found a number of instances in which congenital heart disease was reported. Also, the condition has been found to be more frequent among young inmates of institutions for the feebleminded. None of the reports of cases of bilateral congenital dislocation of the lens have mentioned skeletal defects to justify the idea that the signs of arachnodactyly have been observed in the past but only the changes in the lens reported. Nevertheless, I am sure that the syndrome has escaped observation.

Some of the patients with the complete syndrome observed have shown numerous pigmented clumps adherent to the fibers of the suspensory ligaments, and marked choroidal changes have also been found, even in children. Can one not assume, then, that high myopia

which is strongly hereditary, with its attendant changes in the fundus and the elongation of the eyeball behind the equator, may be due to abnormal weakness of the fibers of the suspensory ligament, allowing the lens to assume a more spherical form accounting for the early myopia, while the changes in the fundus of myopia could be explained as effects of the choroidal disease indicated by the deposits of pigment on the suspensory fibers and the changes in the tapetum?

No satisfactory explanation for arachnodactyly has been given. Weve's theory that the disease is a mesodermal dystrophy satisfies most objections, but not all. The dilator fibers of the iris arise from another layer of the embryo, but they may be ineffective through no error of their own structure but only because the framework of the iris is unyielding. But how can one explain the abnormal weakness of the suspensory fibers that plays such an important rôle in producing the dislocation of the lens? They, too, arise from another layer of the embryo. Vogt suggested that the disease transmitted from one generation to another operates on the chromosomes in the ovum, and the syndrome is complete or partial as more or fewer of them are affected. This is a rather satisfying explanation, but Passow has reported a group of cases in which he pointed out certain features typical of syringomyelia but of a milder degree than is usual in that serious ailment. He argued that many of the symptoms common to arachnodactyly and syringomyelia are the result of improper formation of the neural tube at the stage when the ridge of tissue which connects the submerged neural tube with the surface splits up into two groups of cells on each side of the primitive spinal cord. From these groups of cells, on each side of the median line, one row of cells migrates forward and laterally to form the chain of sympathatic ganglions on either side of the midline, anterior to the spinal column, and the other series forms the chain of ganglions on the posterior sensory nerve roots. In extreme cases the cells surrounding the neural canal are assumed to be affected also, and as their functions are of a trophic nature many of the symptoms characteristic of syringomyelia are explained. In patients with milder syringomyelic symptoms, one sees the changes characteristic of arachnodactyly and also such signs of trophic disturbance as heterochromia and Horner's syndrome, which are disturbances of the sympathetic system. Changes such as abnormal length of the arms (so that the span is greater than the height) and long, thin bones and weak muscles are considered to be trophic. The hands may be very large and their integument moist and soggy. In females, the breast on the side affected by the heterochromia or the Horner syndrome may be much smaller than the opposite breast. Spinal curvatures are common in any type of arachnodactyly. The fingers,

instead of being straight, may be curved somewhat, though the curvature never reaches the degree of the clawhand of patients with syringomyelia. In the minor degree of curvature of this type found in arachnodactyly, only the little finger may retain the aforementioned curvature. Another defect found in the patients in whom the condition is of the syringomyelia type is a sternal groove so deep in some cases that the heart is displaced to the left. Some of these features have been found in the cases reported in this paper, except the syndrome of Horner and the heterochromia. Most of the patients with acquired heterochromia whom I have seen showed evidences of tuberculous uveitis, but now and then a notable exception appeared. Unfortunately, my acquaintance with this aspect of arachnodactyly is so recent that heterochromia has not been studied from this angle.

To some a study of a rare condition of this kind seems profitless. With this view I do not agree. One does not know where study of this condition will lead or what other conditions may be involved in the process producing this unique disorder. Some do not care to study unusual conditions holding no hope of cure. If either of these attitudes is accepted one must not expect another discovery like that of insulin in the field of medicine. At present there is no satisfactory method of finding cases of atypical arachnodactyly unless the patient has the characteristic dislocation of the lenses. That patients with atypical arachnodactyly without ocular symptoms transmit the condition is undeniable. Also, patients with bilateral dislocation of the lenses without body changes become transmitters of the complete syndrome. The practical technic of finding cases of the complete syndrome at present is to work backward or forward in the family of any patient with congenital bilateral dislocation of the lenses. Pedologists do find patients with this condition without the ocular involvement, but it is not known how many patients with mild arachnodactyly without lenticular changes escape detection under the present procedure.

If one fixes firmly in the minds of chiefs of clinics and their associates the importance of the ocular symptoms as an index of this condition, more cases will be found; families with small children can then be studied, and perhaps the condition in the younger patients can be controlled. Whatever the outcome and however rare the condition, this problem is a challenge, and although the more common and serious ocular ailments properly preempt a larger part of the clinician's time and attention, nevertheless there should still be time enough for each to contribute something toward the solution of the problem from the clinical side. As in other questions involving heredity, the laboratory should give important if not decisive information.

A bibliography will be found with my first article, which was presented before the American Ophthalmological Society.[1]

Another bibliography will be found with the very excellent article on this subject by Dr. Frank Burch [2] which was read before the Section on Ophthalmology at the Eighty-Seventh Annual Session of the American Medical Association in June 1935. The only other article published recently is that of Bakker.[3]

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1. Lloyd, Ralph I.: Arachnodactyly (Dystrophia Mesodermalis Congenita; Typus Marfanis; Marfan's Syndrome; Dolichostenomelia), Arch. Ophth. **13**:744 (May) 1935.

2. Burch, Frank: Association of Ectopia Lentis with Arachnodactyly, Arch. Ophth. **15**:645 (April) 1936.

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EXAMINATION AND CARE OF THE EYE IN RELATION TO LIGHTING

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A strong incentive for our work in physiologic optics has been to help prepare the way for a more extensive use of hygienic measures in the care and treatment of the eye. The subject of hygiene has been built up in the attempt to preserve and restore normality of function through regulation of the conditions under which the organ functions. In relation to the care of the organs of the body the growth of hygiene has been rapid. In relation to the sense organs, however, its progress, it would seem, has suffered perhaps undue retardation. Whether this situation is intrinsic or merely marks a stage in the development of the subject time alone can tell. In the case of the eye, at least, it would seem that hygiene can be made to play a much more important part than it now does, that is, that the care and treatment of the eye shall not be so narrowly dependent on the surgical measures of operation and on the use of lenses and prisms.

IMPORTANT STRUCTURAL AND FUNCTIONAL CONSIDERATIONS

In connection with the hygienic treatment of the eye one must consider the muscular equipment of the eye, the structure and parts of the eye itself and the sensorium.

A notable feature of the visual mechanism is the delicacy and intricacy of its muscular equipment, and an important factor in the correctness of the visual performance is the normality of structure and function of this equipment. There are two aspects of hygienic treatment relating to this muscular equipment: (*a*) the correction of the gross and minor imbalances through either suitable exercises or other means as yet poorly defined and (*b*) the prevention of harm to the eye caused by malfunctioning of the muscles due to improper conditions of work. The influence of the grosser abnormalities on the accuracy of the combination of the images of the two eyes in binocular vision has received due recognition and study, but the influence of the lesser abnormalities on the clearness and correctness of the formation of these images has not perhaps been fully realized. One has only to remember how pliable

From the Research Laboratory of Physiological Optics.

the eye is to understand how readily it may be deformed by slight imbalances in the pressure exerted by the ocular muscles in holding it in proper balance in any given position or in executing accurately the many movements it is required to perform. When these pressures are excessive in amount or when there are special conditions of weakness of the coats of the eye, permanent changes in structure may be produced, or the deformities may be present only in situ, that is, only when the eye is subjected to the pressure and pull of the muscles.

In respect to these deformities it will be remembered that deviation toward a prolate spheroid will cause myopia; deviation toward an oblate spheroid, hyperopia, and irregularity in the deviation, astigmatism; that only a slight deviation is required to produce a diopter of defect, and that deformities may occur either in the ball of the eye or in the cornea. In relation to the influence of muscular pressure on the shape of the eyeball, the following points should be considered: the attachment of the straight muscles by a broad insertion well in front of the center of rotation of the eye and their passage around its curved surface to a point at the back and upper part of the socket or orbit, the passage of the two oblique muscles around the eye from their insertion at a point in the back toward the front of the orbit in such a way as to give to some extent the effect of suspending the posterior half of the eye in a noose, and the possibilities presented for excessive pressure or unevenness of pressure in the action of these muscles.

In this connection it should be borne in mind that the muscles have the twofold function of supporting the eye and of moving it and that it is in the relation or proportion of the forces which serve to support the eye that slight imbalances may be expected to occur. Slight disturbances in the relationship between the backward pull or tension of the rectus muscles and the opposing action of the oblique muscles, for example, may serve to change the length of the polar axis and otherwise deform the eye. Further, the correction of the imbalances in case of too strong a pull on the part of the converging muscles would require the action of the antagonistic muscles to prevent confusion of vision due to defective combination of the images of the two eyes, and this in turn might lead to an inequality of pressure which might serve to deform the ball of the eye or the cornea and thus tend to produce astigmatism, perhaps the customary astigmatism with the rule. Or again, in case of asymmetry in the pull or tension of these converging muscles this tendency toward torsion would have to be corrected by an opposing asymmetry in the tension of the antagonistic muscles. This composition of forces would tend to shift the direction of maximum pressure and produce oblique astigmatism.

It should further be remembered that these deformities as produced by the pressure of the muscles of the eye may be either congenital or acquired; perhaps they are most often acquired. It is, of course, in the cases in which the defect is acquired that there is the greatest possibility of success in the use of hygienic measures.

In relation to the pressures produced by the more customary movements of the eye and their tendency to cause elongation of the eyeball, it may be noted that the convergent movement considered from its beginning in what is called the primary position to its end, when the eye has made its maximum excursion inward, is a complicated function of three straight muscles, the internal, superior and inferior rectus muscles. The superior and inferior oblique muscles steady the eye during the excursion and perhaps aid the adduction in the more extreme positions of convergence. The diverging movement is also a complicated function of more than one muscle, the complication varying with the degree of abduction. In contracting, the converging muscles turn the front of the eye inward and press the eye against the external rectus muscle over a considerable portion of its length. The effect of the action of both sets of muscles, converging and diverging, is to exert a backward pressure on the contents of the eye toward the posterior pole, which backward pressure is opposed by the contraction of the oblique muscles. The point of attachment and the course of the oblique muscles, however, are such as to leave a segment of the back wall of the eye without external reenforcement. The front of the eye is reenforced by the pressure of the four straight muscles which are attached, as has already been indicated, on a broad base well toward the edge or limbus of the cornea and by the lens with its suspensory ligament. It is perhaps not too much to expect, then, that under the pressure of sustained convergence rendered excessive by bringing the work closer to the eye under poor lighting conditions and other faulty conditions of seeing the coats of the eye, particularly if they are already weak from congenital or from degenerative causes, should yield in the region of the posterior pole.

In further relation to the harm done to the eye by the malfunctioning of its muscles as a result of poor conditions of work the situation with regard to the accommodation of the eye should not be left out of account.

In the attempt to understand the effects of poor lighting on the eye one of the most fundamental principles to keep in mind is that the eye is always under a reflex incentive to clear up vision. This incentive is so strong that it is extremely difficult to oppose it successfully by an act of the will or voluntarily to force the eye to make an adjustment detrimental to clear seeing. The eye has grown up under daylight. Under this condition only three adjustments have developed, and, indeed, only three are needed: the reaction of the pupil to regulate the amount

of light entering the eye and to aid the lens in focusing the light from objects at different distances and accommodation and convergence to bring the object on the principal axis of the lens and the image on the fovea—conditions necessary for the formation of the clearest images by the lens and for the best discrimination of these images by the retina. These adjustments take place under a sort of triple bond imposed by their common nerve supply, which is so strong that if one takes place the others also take place unless the power of separating them has been acquired, and even then their separation is accomplished only by great effort or strain. Artificial lighting, with its unnatural and unfavorable conditions for clear seeing, has come late in the history of the race, and the eye has not developed any reactions or adjustments to meet the conditions imposed. Yet the incentive to clear up seeing remains and leads to adjustments which, if allowed to take place, serve only further to blur rather than to clear up vision. For example, a change in accommodation, which is a change designed to clear up an image blurred by changing the distance of the object, is in no sense helpful but is only harmful for clearing up an image blurred by poor lighting conditions; yet so long as unclear seeing is present, due either to blurring of the image or to unfavorable conditions for its clear discrimination by the retina, the eye will strive by the three adjustments at its command to remedy the deficiency. This striving of the eye to clear up vision by ineffectual maladjustments is the cause of what is commonly called eye-strain and is an important cause of ocular discomfort. The misdirected effort or strain is of no service to vision and leads rapidly to fatigue and exhaustion, to deformities slight in their physical magnitude but great in their functional importance, to inflammations and congestions and to hypertensions and other conditions not found in a healthy eye. Accommodative strain in itself, for example, leads to hyperemia or congestion of the network of blood vessels just in front of and behind the ciliary muscles. The congestion in this so-called danger zone of the eye leads in turn to an increased flow of fluid into the anterior chamber from the blood vessels on the anterior border of the ciliary muscles and into the vitreous chamber from those on the posterior border of these muscles and, perhaps, through the products of the congestion of inflammation, to a blocking up of the drainage angle between the iris and the base of the cornea. This tends to produce a disturbance in the normal balance of the income and outgo of fluids into the interior of the eye and the evils attending such a disturbance.

If the eye could only be educated to be quiet under the poor conditions of seeing for which it has no specific corrective adjustment the cause of vision would be just as well or even better served, and the eye itself would be a great deal better off.

It is somewhat difficult to trace all the effects of eyestrain. It is not the result of normal exercise of the powers of the eye in either kind or amount, and no possible benefit can accrue from it. Rather it leads to an unhealthy condition of the eye, exaggerating and aggravating any abnormal tendencies or predispositions already present, lowering the normal recuperative and restorative powers of the eye and leading sympathetically to functional disturbances in other parts of the body. Like any other organ of the body, the eye if it is to remain healthy or to cure itself of any of its ills, congenital or acquired, must first be put into a situation calling only for the healthy exercise of its normal functions. Important factors in this situation are the conditions under which it is ordinarily called on to work.

OUTSTANDING FEATURES IN LIGHTING IN RELATION TO THE EXAMINATION AND CARE OF THE EYE

The two important aspects of conditions of work as regards the eye are the type of work and the illumination. In relation to the type of work the following are to be considered if the work involves the discrimination of print on paper: the reflecting power of the paper and the type of reflection; the color of the paper; its texture and opacity; the blackness and flatness of the ink used; the size of the page or area of reading space exposed at any one time; the size, shape and spacing of print, and other factors. It is not, however, our purpose to do more than list these items here. In relation to the illumination of the work, we shall consider only four points in the present discussion: the intensity of the illumination, glare, the placement of the light and the color of the light. We have selected these, first, because of their fundamental importance and, second, because we are completely equipped to provide hygienic conditions with respect to them.

Intensity of Illumination.—One of the most outstanding facts with reference to the intensity of the illumination is the wide variation that is found in the amount of light needed and preferred for different types of work, for persons of different ages and for different persons doing the same type of work and in the same age group. Important factors in these individual variations are: age, the refractive condition of the eye, the health of the eye, the clearness of the media, the size of the pupil, susceptibility to glare and the keenness of discrimination of light and space. If too little light is used low visibility results, and the eye undergoes all the strain and malfunctioning of the muscular equipment discussed in the preceding paragraphs. In case too much light is used the excessively harmful effects of glare are experienced. For by far the greater number of persons the range of toleration for the comfortable use of the eyes is comparatively narrow for light of Mazda

quality, and somewhere in this range is a pretty clearly defined preferred intensity. While the correct adjustment of intensity is extremely important in the case of all eyes it is of paramount consideration in the case of those eyes which come under the care of the ophthalmologist. It is not enough to say that one shall or shall not use one's eyes for reading or work or to say that they shall be used only for a certain number of hours a day. The conditions under which they can be used should be prescribed, and the prescription should be accompanied by the information needed to carry out the recommendations. In this way not only would the eyes in question be greatly benefited, but a much greater amount of work could be allowed.

There are two ways of dealing with the situation with regard to the regulation of the intensity of the light to suit individual needs. 1. It can be found what a person's range of toleration of intensity for the comfortable use of the eyes and his preferred intensity are. A prescription can then be given advising what intensity he should have. For this purpose instruments of the type of our variable illuminator [1] can be conveniently used. This procedure is not, however, completely satisfactory, because of the difficulty the patient will have in filling the prescription with such lighting equipment as he is able to procure. In this connection it must be remembered that the preferred intensity must be closely approximated or the prescription will signally fail to accomplish its purpose and, further, that the exact amount of light needed varies with the kind of work, the time of day, the variation in the condition of the eyes and other factors. It is impossible satisfactorily to take account of all these factors in a single test period. Again, the patient may not even attempt to fill the prescription because of the trouble involved and the amount of technical knowledge and understanding it would entail. 2. A much more satisfactory procedure is to use the test only for the purpose of finding out approximately what the patient needs and then to recommend the use of a local lighting unit provided with an intensity control over the range which satisfies his requirement. He can then at any time and for any work adjust the intensity of light exactly to suit his needs. The purpose of the test in this procedure is that the examiner may find out the type of eye he is dealing with for his own enlightenment in relation to the care of the eye and that he may recommend the right type of lighting unit. To meet this need for a variable intensity we have devised desk and table lamps, floor stand lamps and bed reading and examining lamps, provided with mechanical

1. Ferree, C. E., and Rand, G.: Lamp for the Determination and Measurement of the Preferred Intensity of Light for Reading and for Other Work, Arch. Ophth. **12**:45 (July) 1934.

controls which change the intensity of the light in continuous series but do not change the color or composition of the light or the size, shape or location of the illuminated area.

It would be an ill considered practice in lighting to make a blanket recommendation of a certain intensity of illumination or a narrow range of intensity for all persons, even for the same kind of work. It will also be realized how difficult it is adequately to handle the problem of intensity by general illumination alone for any considerable number of workers. In some cases it is possible by means of information obtained by testing a group of workers so to distribute them in a room lighted by general illumination as to give some consideration to their individual needs. We have been able to accomplish this result with notable success in a room in a large publishing house used by fifty or more proofreaders. In this case a systematic measurement was made of the intensity of illumination of the room, and each of the proofreaders was tested for the preferred intensity of light and then assigned to a location in the room that most nearly met the requirement. No significant change was made in the lighting of the room. The ideal way to handle the problem, however, would be to provide a suitable intensity of general illumination and use local lighting with variable control of intensity in individual cases.

Glare.—Glare is of two types, simple and veiling. Simple glare is too high brightness in any part of the field of view due to excessive stimulation of the sensorium by light. In the center of the field it is commonly called glare on the work; in the peripheral field it is usually due to the source of light, the lighting fixtures, high reflections and poorly controlled or misplaced intensities of light. Glare on the working surface may also be of the type known as veiling glare. Veiling glare is an obscuring of the image on the retina produced either by an overlay of scattered light or by light reflected from the work surface which is not focused. The former is due to the diffusing or scattering properties of the lens and other media of the eye, and the latter, to specular reflection from the work surface itself. In the latter respect it may be said that the light diffusely reflected from the working surface alone produces an image of that surface on the retina; the light specularly reflected would, if focused, produce an image of the source, not of the working surface. The eye in viewing the working surface naturally adjusts itself to focus the diffusely reflected light. This leaves the light specularly reflected unfocused. In proportion, therefore, as one has specular reflection the image of the working surface is blurred and confused.

The experience of simple glare ranges from a feeling of too much light or an annoying brightness through the various stages of discomfort

to acute pain. Veiling glare by producing confusion in the images causes eyestrain or discomfort through a misdirected and futile effort on the part of the muscles of the eye to clear up its images. That veiling glare causes eyestrain and discomfort is not difficut to understand. It is not so easy to explain the acute pain often caused by simple glare. This is perhaps due to a sharp contraction of the pupil, particularly if the iris is inflamed or supersensitive, or to some condition or reaction set up in the eye itself or in the sensorium. In any event it is a warning or danger sign that harm is being done to the eye. In connection with the pain and discomfort experienced it will be remembered that the iris and other parts of the eye are richly supplied with pain nerves.

Eyes differ greatly in their susceptibility to glare. A study of this susceptibility and of the factors that cause it is an important need in relation to the care and welfare of the eye. It is especially important that susceptibility to glare and the requirements relating to the intensity of light should be studied in the case of diseases of the eye and in the case of some of the more serious defects in refraction and other refractive errors that produce an irritable and supersensitive condition of the eye. We have, for example, observed the acute susceptibility to glare in cases of glaucoma, retinitis pigmentosa, iritis and conjunctivitis, high myopia, marked difference in the refractive condition of the two eyes and uncorrected or poorly corrected astigmatism.

In general the following subjective factors may be noted in connection with susceptibility to glare: age, the size of the pupil, the condition of the media of the eye, the health of the eye and the general health, marked asymmetry of refraction of the two eyes, high myopia and refractive errors that produce an irritable and supersensitive condition of the eye, ocular and bodily fatigue, loss of sleep, insomnia, etc., and the following objective factors may be noted as predisposing to glare: the reflecting power of the surface viewed and the character of the reflection (specular or diffuse), the size of the reflecting surface, the intensity of the light, the angle at which the light falls on the work and the breadth of the angle of the incident light, the diffuseness of the light, the color and composition of the light, high brightnesses in the paracentral and the peripheral field of view and their angular relation to the line of sight, etc.

The most acute problem in modern lighting from the standpoint both of hygiene of the eye and of the designing of lighting equipment has been, it scarcely need be pointed out, the elimination of glare.

Placement of Light and Brightness.—A third important feature in lighting is the correct placement of the light. This problem was created with the devising of lamp-shades for shielding the eye from glare and later giving these shades a reflecting lining to conserve and direct the

light. When the opening of the reflector was turned down the light was directed toward the plane of the work, and the walls and ceiling were left dark or poorly illuminated. On the other hand, when the opening of the reflector was turned up the light was directed to the ceiling and from there reflected to other parts of the room. This resulted in a disproportionately high brightness of the ceiling and a correspondingly low intensity of light on the plane of the work. Relief from the glare of the opening was obtained at the cost of poor and inefficient placement of the light. As a compromise between these extremes in the placement of the light recourse was had to inverted translucent bowls or housings which reflected part of the light to the ceiling and transmitted a part laterally and downward, to opaque housings or reflectors which directed part of the light upward and part downward (direct-indirect units) and to diffusing globes. While these units gave a better placement of light than either the totally direct or the totally indirect units the protection afforded against glare was far from adequate. In a later paper we shall show that the most favorable placement of light and brightness in respect to the walls and the ceiling is that in which the maximum brightness is near the level of the eyes of the worker, with an even and gradual decrease in both directions upward and downward, thus giving the upper part of the walls and the ceiling, for example, less than the maximum brightness. The next step in the development of lighting fixtures has been the use of baffles to give the minimum interference to the distribution of light from the source and the maximum protection against glare. This development has been discussed in former papers [2] and will be noted later in the present paper.

An important feature in the designing of equipment for both general and local lighting is the provision of a means for varying the placement of light to suit the needs of the particular situation. One of the difficulties in securing good lighting effects at present is the lack of flexibility and variety in this respect. The units that can be had ready-made of a stock or standard type differ widely in the lighting effects that they produce. Thus it is somewhat difficult to adapt the units that are available to such situations as are presented by rooms of different sizes and shapes, of different ceiling heights, characteristics of the walls and the ceiling with respect to contour and surfacing and the purposes for which the room or enclosure is to be used. This difficulty is sometimes met in what is called custom-made lighting by using units of special

2. Ferree, C. E., and Rand, G.: Lighting Without Glare, Arch. Ophth. **8**:31 (July) 1932; Lighting Without Glare: A Further Contribution, ibid. **9**:344 (March) 1933; The Glareless Lighting of a Dark Room, Am. J. Psychol. **45**:735 (Oct.) 1933; A Bed Lamp Designed to Give Glareless Illumination, Mod. Hosp. **43**:78 (Nov.) 1934.

design and more than one type of unit in the lighting of the enclosure. A further possibility, as will be noted later in the paper, is to make provision in the unit itself for variability in the placement of the light. This can be done in both the general and the local lighting units, perhaps more easily and conveniently in the local units. It is possible, for example, in the designing of local lighting units practically to eliminate glare from the working surface without undue loss of luminous efficiency by suitable means for varying the direction and placement of the light on the work. A description of this means will be given in a later paper.

Color and Composition of Light.—Among the reasons why the color and the composition of light are to be considered of importance in the care and welfare of the eye the following may be noted: 1. Colored light gives the eye less power than colorless light to see objects of neutral color. In former papers [3] we have shown this with light taken from the spectrum, filter colors and colored illuminants. The functions tested were acuity, speed of discrimination, power to sustain clear seeing and ocular fatigue. Black test objects on white backgrounds and the reading page were used as material for the tests. In every case with colorless light, i. e., color-corrected light or light of daylight quality, the subject gave a better performance in all these respects than with colored light. For the spectrum light the best performance was in the yellow part (around the wavelength of 578 millimicrons). On each side of this there was a decrease toward the long and short wavelengths at the ends of the spectrum, the difference in performance varying with the function tested; that is, the decrease was greater for speed of discrimination than for acuity and greater for power to sustain than for speed of discrimination, as might be expected from the fact that the addition of speed and power to sustain adds sensitivity in any performance used as a test. In carrying out these tests the test surface for each color was made of the same brightness and saturation. This equalization as to saturation and brightness was also made in the tests with filter colors and colored illuminants. An important factor in these differences of performance is that the difference in sensation is greater for black on white than for black on any color and greater for black on yellow than for black on any other color. In this connection it will be remembered that the visibility of an object depends on its difference from the background as well as on its size.

3. Ferree, C. E., and Rand, G.: The Effect of Variation of Visual Angle, Intensity and Composition of Light on Important Ocular Functions, Tr. Illum. Engin. Soc. **17**:69 (Feb.) 1922; Further Studies of the Effect of Composition of Light on Important Ocular Functions, ibid. **19**:424 (May) 1924; Visibility of Objects as Affected by Color and Composition of Light: I. With Lights of Equal Luminosity or Brightness, Personn. J. **9**:475 (April) 1931; II. With Lights Equalized in Both Brightness and Saturation, ibid. **10**:108 (Aug.) 1931.

2. The color and composition of light, as well as its intensity, are factors in causing glare. This is apparently true for both simple glare and veiling glare. Glare occurs, for example, at lower intensities with artificial light than with daylight and light properly corrected for color. And, again, it seems that colored lights differ among themselves in their tendency to produce glare. Just why these differences should be present in the case of simple glare it is somewhat difficult to understand. In the case of veiling glare they are doubtless due to the difference in the tendency of the media of the eye to scatter lights of different wavelengths and composition.

3. There is a greater tendency for colored light to produce ocular discomfort than for white light to do so. This tendency also differs among the colors themselves. This is found to be true both when the lights in question are used as illuminants and when the eye is exposed to them without any effort or attempt to discriminate detail.

The effect of color on the eye's comfort and performance varies a great deal for different persons. Eyes made irritable and supersensitive by refractive defects and disease seem in general to suffer most from color in light. It may be said, however, that daylight and artificial light properly corrected for color are better for all eyes than colored light.

MEANS FOR IMPROVING LIGHTING CONDITIONS

The lighting in current use is characterized by a high and harmful glare which is becoming worse as the level of the intensity rises, and little means are being provided for adapting the intensity and placement of light to the various needs and conditions that arise. From our point of view, eliminating glare and varying the intensity and the placement of the light as may be needed are three of the four important points in good lighting. The fourth is commercially feasible correction for color.

Work on lighting in relation to the eye is not complete so long as it is confined to the study and investigation of principles and factors. Means must be found for applying what has been learned to the betterment of lighting conditions. After more than twenty years of study and experimentation in relation to factors and principles we have begun to try what we can do to improve lighting conditions, particularly with reference to intensity, glare and placement of light and brightness. We have, for example, devised means whereby any intensity of light that would be needed in both usual and unusual lighting conditions can be secured with complete elimination of glare. This has been accomplished by the use of glare baffles or a plurality of nonreflecting light-shades of suitable size and shape so worked into the design of the fixture or housing of the source of light as to shield the eye completely from the glare of the lamp itself and all auxiliary reflecting surfaces and to give

such wide and uniform distribution of light as to eliminate entirely all high and uneven brightnesses on the walls and ceiling. These baffles have also been used to meet the needs and requirements of local lighting. We have further included in local lighting the important feature of variable intensity of light, as has been noted earlier in the paper, and in both general and local lighting, that of variable placement of light, and provisions have been made for correction of color when that is desired.

Our list of devices includes the following: inset, ceiling and wall-bracket fixtures for commercial lighting and the lighting of hospitals, offices and homes; bed reading and examining lamps; desk and table lamps; floor stand reading and bridge lamps; lamps for the lighting of lecterns and speaker's desks; a device for lighting tunnels and corridors and for protection from glare from automobile headlights, and lamps for the optician's fitting table and the refractionist's chair.

We have considered it worth while to note these devices here in order to show that it is possible to carry out the hygienic measures with reference to lighting that we have recommended for the care and treatment of the eye. Whether the means that we have devised or some other means shall be adopted is of secondary importance. The primary thing is to show that such results can be accomplished in ways that are entirely practical and commercially feasible. A too great obstacle to this end is encountered in relation to those who make and sell lighting equipment. The reasons for this are in part conventional but largely commercial. The change from the traditional form of lighting requires the adoption of new ideas and new ways of thinking, and somewhat radical changes in manufacturing equipment. Further, the manufacturers of lighting equipment contend that there is no convincing public demand for better lighting. If and so far as this is true, there is need for competent and earnest educational service. In this respect the public naturally looks for guidance to physicians, in particular to the eye specialist. Our own experience, however, leads us to believe that the public is willing and eager to have better lighting if they knew what to get and where and how to obtain it.

MEANS AND METHODS OF TESTING

A complete program for prescribing light should have the following features: 1. Tests should be made of the subject's preferred intensity of light and his range of toleration for intensity for the comfortable use of the eyes for the work he is most accustomed to do and for different types of work, of his susceptibility to glare and of his need for correction for color. 2. From the results of the tests just mentioned recommendations should be made as to the intensity of the light that

he should use and the type of lighting equipment that will satisfy his needs in this respect and in respect to protection against glare and harmful coloration of light. With respect to glare, it may be said that, while no eyes should be exposed to glare, more latitude can be allowed to some than to others. It is hoped and expected that in course of time the control of glare in public places at least will become a matter of public health and safety regulation.

All the aforementioned tests can be made easily and conveniently with an instrument that we have called a variable illuminator. The purpose of this instrument is to provide a means of varying the intensity of the illumination in continuous change over a wide range, e. g., from 0 to 100 foot-candles without change in the color or composition of the light or in the size, shape or position of the illuminated area, and to provide a means of correcting artificial light to light of daylight quality. The essential features of the instrument are a source of light of adequate intensity to give the range needed, a housing of suitable size and shape, a mechanical means or specially designed shutter for varying the intensity of the light and a diffusing plate or other diffusing means both to eliminate completely shadows which would otherwise be produced by the shutter and to give an evenly distributed and well diffused illumination of the test surface. The laboratory model of this instrument was described in a former paper [1] and mentioned in a still earlier paper.[4] It will suffice here to describe the means employed for varying the intensity, for diffusing the light and for giving the correction for color.

The means of varying the intensity consists of four vanes which extend across the opening of the housing in such relation to each other that when their flat surfaces are parallel to the beam of light the maximum amount of light passes through the opening, and when they are rotated to a position at right angles to the beam the light changes in continuous series from full intensity to zero. In changing the intensity the vanes are so activated as to cause the contiguous vanes to turn in opposite directions. This insures absence of shift in the position of the illuminated area and absence of change in its size and shape. When the vanes all move in the same direction, as is the case with Venetian blinds, all these changes take place. In the various models of the instrument different means of activating the vanes have been employed. For one of the models a simple means has been devised which lies within the housing and is entirely free from slack or backlash. This is in the form of a thin plate with a central longitudinal slot through which pass

4. Ferree, C. E.; Rand, G., and Lewis, E. F.: The Effect of Increase of Intensity of Light on the Visual Acuity of Presbyopic and Non-Presbyopic Eyes, Tr. Illum. Engin. Soc. **19**:296 (April) 1934.

the axle pins at the ends of the vanes. This slot permits the plate to travel back and forth as the vanes turn. Above and below it in alternate sequence are short vertical slots which engage pins suitably positioned at the ends of the vanes. To the end of the axle of one of the vanes is attached a knob. When this knob is turned the contiguous vanes rotate in opposite directions as is desired.

The intensity of the light on the test surface for any position of the vanes can be read from a calibrated scale suitably positioned on the instrument. The spread of the light from the opening has been checked at several distances to make sure that it follows the law of squares; thus, if a rating of the intensity is desired at any other distance it can readily be computed from the reading on the scale. To secure constancy of current an ammeter and rheostat may be used, if desired. Also the intensity of the light can be measured with a photometer, or light meter, instead of being read from the scale.

In order that no shadow shall be cast by the vanes in any position in their rotation a plate of Belgian flashed opal glass is mounted directly in front of them, between them and the surface to be illuminated. In addition to eliminating completely all shadows on the illuminated surface, this provision secures exceptionally good diffusion of light. For correction for color this diffusion plate may be slipped from its position in front of the vanes and the correcting filter inserted. Any color filter that is desired may be used for this purpose.

The use of such vanes as we have employed in combination with a diffusing plate to eliminate shadows provides a simple mechanical means of varying the intensity of illumination over any range that may be desired and one that is free from the objections as to effects of illumination and inconvenience of use which may be noted in connection with other ways of reducing intensity, such as changing the distance of the source, and the use of a rheostat. Further, this means is readily and easily adaptable to lighting fixtures and equipment of various types and to instruments supplied with special lighting devices.

To meet various needs, models have been designed for mounting on a floor stand, on a bracket which can be clamped on the edge of a table or the arm of a chair and on a stand suitable for desk or table use. In these models the weight has also been greatly reduced, the lightest model weighing approximately 2 pounds (0.9 Kg.). A convenient carrying kit for field work and a suitable handle for holding the unit in any position in relation to the work that is desired have been provided.

Test for the Preferred Intensity of Light.—In earlier papers we have shown the effect of intensity of light on such important func-

tions as acuity and speed of vision [5] and on acuity at different ages,[6] and in a paper as yet unpublished we shall show its effect on the speed of vision at different ages. In these papers it was shown in general how much the powers of the eye could be increased by increasing the intensity of the light. However, in such determinations no account is taken of what intensity is preferred for different types of work or what range of intensity is favorable. That is, no account is taken of glare on the work as determining the upper limit, and of diminished acuity as determining the lower limit, of the amount of light that can be used with comfort. The difference between these two limits may be roughly called the range of toleration for the intensity of light. Intensities above the upper limit for comfort may be used in cases of emergency, for example, to give higher visibility, when needed, or a higher speed in the use of the eye, but they can hardly be recommended for ordinary uses of the eye or as best for it over long periods of time.

It is our purpose here to describe a test for the preferred intensity of light and for what we have just called the range of toleration for intensity.

Before making the test the curtains should be drawn and the artificial light in the room turned off. Because of the wide spread of light from the test instrument (140 degrees) general illumination is not needed. The instrument provides a favorable test condition in relation to the illumination of the surrounding field. That is, as the light on the reading page is increased there is a corresponding increase in the amount of light in the surrounding field. This avoids any tendency toward a spot-light effect as the intensity of illumination on the test surface is increased, and gives a type of illumination similar to that which would be obtained in a lighting system in which the increase of intensity is produced without an increase in glare. It should be remembered that there will be a low tolerance for the intensities of light that are needed for good seeing if the increase of intensity is accompanied by an increase in glare. In this connection it may be noted that with our variable illuminator and our glareless local and ceiling lighting units the test can be made and the prescription filled under the same conditions; namely, any intensity of light that may be desired in a practical lighting situation can be obtained without glare.

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5. Ferree, C. E., and Rand, G.: The Effect of Variations in Intensity of Illumination on Functions of Importance to the Working Eye, Tr. Illum. Engin. Soc. **15**: 769 (Dec.) 1920; The Effect of Variations in Intensity of Illumination on Acuity, Speed of Discrimination, Speed of Accommodation and Other Important Eye Functions, Tr. Am. Ophth. **19**:259, 1921; The Effect of Increase of Intensity of Illumination on Acuity and the Question of the Intensity of Illumination of Test Charts, Am. J. Ophth. **6**:672 (Aug.) 1923.

6. Ferree, C. E.; Rand, G., and Lewis, E. F.: Age as an Important Factor in the Amount of Light Needed by the Eye, Arch. Ophth. **13**:212 (Feb.) 1935.

In conducting a test of this kind no direct light from the instrument should fall on the patient's face to cause objectionable glare. Further, in the case of patients wearing glasses the light should never come from above or behind on either side, because of harmful and annoying reflections from the rims and lenses of the glasses. In making the test with our variable illuminator the patient is seated beside the instrument with his eyes back of the flaring bonnet or shield surrounding the opening of the housing. Thus no light falls directly on his face, and the light does not come from above or behind him. In order to give consistency and correctness of result and avoid the need of making a number of trials, the size of the pupil and the sensitivity of the retina should be standardized by exposing the eye for a suitable length of time to a properly selected intensity of illumination before beginning the test. The omission of this precaution is inexcusably bad technic.

Three sizes of type printed on test sheets of unglazed paper are used, one of the size ordinarily used in printing books (10 point), one of the size used for magazines and newspapers (8 point) and one of the customary fine print used for footnotes (6 point). The examiner may use anything else about which the patient wishes information.

The patient should be seated directly in front of the test material at a distance of about 18 inches (45 cm.) or, in case of a presbyope, at the distance needed for his reading glasses, and his eyes exposed for three minutes to the intensity of illumination on the test surface selected as standard for this purpose. Five foot-candles is suggested because it is judged to be fairly representative of the amount of light that is now being used by the persons who will be tested, the purpose of the test being to find out whether this is sufficient or how much more should be had. Moreover, we have found little difference in the result when the exposure was to 5, 10 and 20 foot-candles and in many cases no difference whatever when the test was made in accordance with the instructions given in the following paragraph, namely, when the series of intensities presented for the patient's judgment is given sufficiently slowly to allow the size of the pupil and the changing sensitivity of the retina adequately to keep pace with the changing amount of light. Except in cases in which the patient's eyes have previously been exposed for some time to very high or very low intensities of illumination we have found three minutes of exposure to be long enough to bring the eyes to a practically constant state of sensitivity to the illumination selected for the preexposure. In this connection it should be remembered that adaptation to light is much more rapid than adaptation to dark. That is, the eye when exposed to light loses sensitivity much faster than it recovers after exposure to light.

The full range of intensity of the instrument should be run to give the patient the experience of the different intensities. Then, beginning below 5 foot-candles, the intensity should be increased very slowly in order to give the size of the pupil and the changing sensitivity of the retina a chance adequately to keep pace with the changing amount of light. The patient should be instructed to report when enough light is had for comfort in reading the test material. This intensity should be recorded and the increase continued very slowly, the patient being asked to report when the intensity is too great for comfort or is beginning to be glaring. The difference between these two points is roughly the favorable range, or the range of toleration for intensity. The patient is next instructed to turn the knob on the intensity control and find for himself just what intensity he most prefers. He should be allowed all the time he desires to make this determination. Two results are thus obtained—the favorable range, or the range of toleration for intensity, and the intensity most preferred. Both these should be recorded on the prescription given the patient. The favorable range, it may be noted, is wider for daylight and for artificial light corrected for color than for uncorrected Mazda light. It is, of course, wider also for eyes insensitive to glare. The tests for determining the amount of light needed for reading should be made for the three sizes of print in order of the largest to the smallest and then should be repeated for the largest size in order to minimize the effect of practice. If there is a difference in the result the second value should be used.

In making a test of this kind the greatest danger that is incurred is that the examiner may force the results or prejudice the mind of the observer as to what intensity he should report as most favorable. It is extremely important that the examiner should himself have no prejudice or allow himself to be prejudiced as to what results should be obtained and what prescription should be given as to the amount of light the patient should use. Correct prescriptions, if followed, will lead, on the whole, to the use of a great deal more light than is now being used, but the light will be distributed in accordance with actual needs. Results of studies made with this test will be given in later papers.

Tests for Susceptibility to Glare.—These tests have the following points of interest: 1. They sustain an important relation to the clinical examination of the eye. A test of simple glare is essentially a test for photophobia, made under better conditions and perhaps with a clearer understanding of the exact purpose of the test than when one is dealing with photophobia. It is not our purpose to give here a clinical evaluation of a test for photophobia, but it may not be out of place to point out that a diagnosis can rarely be made from the results of any one type of

test alone and that it is entirely wrong to gage the value of a test only or even predominantly by its possibilities in this direction. In the selection of tests for a diagnostic program, for example, the important thing is not so much whether one test shows more than another as whether it shows the same thing as that other. All diagnosticians will agree, we think, that competent diagnosis is based on as complete a picture of the condition as it is possible to obtain. Prejudice, inexperience or the lack of a just understanding alone could lead, it would seem, to any other conclusion. A test for veiling glare is a test for clearness or its converse, cloudiness of the media of the eye. Again, this sustains an important relation to more than one pathologic condition of the eye and similarly should be considered as filling out the diagnostic picture. Further, quite aside from questions pertinent to the diagnosis, any test which will serve as a sensitive means of detecting changes in the cloudiness of the media should form a valuable addition to the list of clinical tests. Inspection, it is scarcely needful to point out, is not adequate for this purpose.

2. Tests for susceptibility to glare should have a place in a well rounded and representative program for the general examination of the eye. Like the physical examination in general medicine, such a program sustains a broad relationship the details of which need not be gone into here.

3. Tests for susceptibility to glare have perhaps their greatest importance in relation to the care and treatment of the eye. While all eyes should be protected against glare, great care should be exercised in this respect in the case of eyes which show unusual susceptibility. As will be shown later, the variation in this susceptibility, even among eyes not classed as showing a pathologic condition, is astonishingly great. In relation to tests, proportionately too much stress perhaps is put on their value in regard to diagnosis. Too often after the diagnosis is made one does not know what to do about the condition. In this connection tests which have for their purpose the determination of what is needed for the care and welfare of the eye in question obviously should not be overlooked.

The prime requisite for making a test for susceptibility to glare is to have a means of varying the intensity of the light in continuous series over a sufficiently wide range without altering the color or composition of the light or the size, shape or location of the illuminated area. For this purpose we have two instruments to recommend, our variable illuminator and our instrument for testing the light sense.[7]

7. Ferree, C. E., and Rand, G.: A New Type of Instrument for Testing the Light and Color Sense, Am. J. Ophth. **14**:325 (April) 1931.

In the test for simple glare with our variable illuminator, the light may be thrown on a mat white surface of good reflecting power, such as Hering standard white paper, and of suitable size, such as the size of the reading page, this surface to be viewed at the reading distance when the test is being made for susceptibility to glare in reading, or on a sheet of diffusing glassware positioned 5 or 6 inches (12.5 to 15 cm.) in front of the opening of the illuminator. In the latter case the conditions of the test are the same, with the exception that the glare is produced by transmitted light. In using the instrument for testing the light sense for the test, the glare surface is the illuminated field of the instrument. By means of the iris diaphragm provided in the instrument for varying the size of the illuminated field, the glare surface may be adjusted to the size desired. In case a different shape of glare surface is desired, this can be obtained by throwing the iris diaphragm wide open and inserting in the slot provided for the purpose a stop or diaphragm of the shape desired. The test may be conducted in a dark room or, if that is not available, in a room from which all light excepting that coming from the test instrument is excluded as nearly as possible. In order to standardize the sensitivity of the eye, it should be exposed for three minutes to the test field illuminated at some suitable low brightness, which should be kept constant from test to test. The light in the test field should then be varied gradually from low toward high until the threshold of glare or uncomfortable brightness is reached, due precaution being taken with respect to factors that might influence the constancy of this result. Since the size of the pupil is an important factor in susceptibility to glare, an artificial pupil should be used in cases in which it is desired that this factor shall be ruled out. An artificial pupil is provided in the eyepiece of our instrument for testing the light sense. Means for this control are not provided with the variable illuminator. In case this instrument is used the artificial pupil may be worn in a trial frame, or our device for varying the size of the pupil described in an earlier paper [8] may be used. The latter device is admirable for the purpose.

In making the test for veiling glare also either the variable illuminator or the instrument for testing the light sense may be used. In case the variable illuminator is employed a detail of suitable size and shape differing from the background may be stenciled or impressed at the center of the diffusing plate used as both the background and the surrounding field. The conditions with reference to the amount of light in the room and presensitization or preexposure of the eye may be the same as those described in the test for simple glare. Again the light

8. Ferree, C. E., and Rand, G.: A Convenient Device for Using Artificial Pupils of Different Sizes, Am. J. Ophth. **15**:632 (July) 1932.

is varied from low brightness toward high brightness until the detail at the center of the field is completely obscured. Then the intensity should be varied below and above this point until the determination is made with certainty of the highest intensity at which the detail is still visible and the lowest intensity at which it disappears. The average of these two results should give a fairly correct and reproducible value of the threshold of veiling glare. In case the instrument for testing the light sense is used, the detail can be impressed at the center of a plate of clear, colorless glass and this plate can be inserted in the slot provided in front of the field lens. The method of testing is then the same as that described with the variable illuminator.

No attempt should be made to compare the results obtained with the two instruments in testing for either simple glare or veiling glare. Either instrument should give consistent results from time to time with the same person and comparable results for various persons and various places, but one instrument cannot be substituted for the other. In the latter connection it should be borne in mind with reference to the determination of simple glare that the test field in the two instruments is obtained in different ways. With the variable illuminator it is obtained by illuminating a diffusely reflecting or diffusely transmitting surface, and this is viewed by the eye in the ordinary way, while with the instrument for testing the light sense it is obtained by focusing a collimated beam of light in the pupil of the eye by means of a lens, on the principle that when a parallel beam is focused in the pupil of the eye the lens is seen as uniformly filled with light. In the case of the test for veiling glare, not only this difference is to be considered but the fact that there is presented in the variable illuminator an initial amount of scatter of light due to the diffusing action of the test surface, while in the instrument for testing the light sense there is present only the scattering action of the media of the eye. Just how much this initial scatter, by multiplying the number of angles at which the light enters the eye, influences the scatter caused by the media of the eye and thereby perhaps influences the sensitivity of the test cannot be told at this time.

In the test just described, it will be noted, the visibility of the detail to be discriminated is held constant and the intensity of the obscuring or glare-producing light is changed until the threshold of discrimination is obtained. It is obvious that the converse of this principle could also be used; namely, the intensity of the obscuring or glare-producing light could be kept constant, and the visibility of the detail to be discriminated could be varied until the threshold of visibility was obtained. If the latter principle were used our variable illuminator or some device provided with a shutter means of changing the intensity of illumination could be employed with convenience and advantage to vary the visibility of the detail to be discriminated.

The practical test, considered in relation to prescribing light, is a composite one which takes into account both simple glare and veiling glare. We refer to the determination of the upper limit of intensity for comfortable reading, which has been described under the heading "Test for the Preferred Intensity of Light." This test has the further advantage that it is made in the routine procedure of testing for the preferred intensity of light. It will be understood, of course, that in nonpathologic conditions simple glare is the major factor in this determination.

We have studied with this test five hundred and fifty subjects with no pathologic condition of the eyes, ranging in age from 10 to 77 years.[9] A brief summary of the results obtained may be given here to show the wide range of variability that may be expected in susceptibility to glare in healthy eyes as measured by the upper limit of intensity for the comfortable reading of a page of ordinary type (8 point) and the importance of the need for testing for this susceptibility in relation to the care of the eye. An upper limit of intensity for comfortable reading of less than 5 foot-candles was found in 1.7 per cent of the cases. This limit was between 5 and 10 foot-candles in 11.3 per cent, between 10 and 15 foot-candles in 26.5 per cent, between 15 and 20 foot-candles in 20.8 per cent, between 20 and 25 foot-candles in 11.2 per cent, between 25 and 30 foot-candles in 6.5 per cent, between 30 and 35 foot-candles in 4.7 per cent, between 35 and 40 foot-candles in 3.3 per cent, between 40 and 45 foot-candles in 2.2 per cent and between 45 and 50 foot-candles in 3 per cent. The remaining 8.8 per cent had an upper limit of toleration for intensity of between 50 and 100 foot-candles. Thus it will be seen that for 13 per cent the upper limit of intensity for comfortable reading was less than 10 foot-candles; for 14 per cent, above 40 foot-candles; for 73 per cent, between 10 and 40 foot-candles; for 65 per cent, between 10 and 30 foot-candles; for 58.5 per cent, between 10 and 25 foot-candles, and for 47.3 per cent, between 10 and 20 foot-candles. From these data it might be considered that those who have an upper limit of less than 10 foot-candles are more than usually sensitive to glare and that those who have an upper limit of less than 5 foot-candles are extremely sensitive to glare, while those who have an upper limit of more than 30 or 40 foot-candles are less than normally sensitive to glare.

Test for the Need of Correction for Color.—The purpose of such tests is a determination of a condition which might be called chromophobia or chromasthenopia, that is, an unusual susceptibility to discomfort due to color in light. In the case of all eyes there is, so far as we know, a preference for light of daylight color. Reasons for this are

9. This study was made in collaboration with E. F. Lewis.

the greater comfort and efficiency that it gives, a lesser tendency to produce both simple glare and veiling glare and the higher visibility that is obtained for objects and backgrounds of neutral color, such as black objects on white backgrounds. There seems, however, to be no pressing reason for using the test unless the history shows an undue amount of physiologic aversion to artificial light, although many are more than willing to bear the expense of correction for color for the sake of the additional comfort and benefit it gives. The particular need for it is in those cases in which there is a complaint of distress in working under artificial light. In such cases it should be used in conjunction with tests for preferred intensity of light and susceptibility to glare in the endeavor to isolate the cause of the trouble. It would be well for the physician to take advantage of the information that can be had from these tests in all cases in which he is accustomed to proscribe entirely or to limit the use of artificial light. In our own experience we have had a great deal of success in prescribing the use of color-corrected light in cases of diseases of the eye and of troublesome refractive defects or in cases in which there is undue nervous and ocular irritability.

Space might perhaps be allowed here for two examples. One is that of a distinguished research worker, scholar and teacher about 70 years of age, the acknowledged leader in his field. This patient was entirely unable to work at night under ordinary conditions of lighting. So far as was known, there were in his case no pathologic condition of the eyes and no unusual refractive defect. Under artificial light properly corrected for color he was, according to his own statement, able to work, if he chose, until 2 or 3 a. m. His own version of the result was that color-corrected light had saved his nights for him. The other case is that of a well known editor and journalist about 60 years of age. This patient had lost the sight of one eye owing to disease, and the condition of the other eye was poor. He had been forbidden to work or read at all under artificial light. His testimony likewise was that color-corrected light made it possible for him to work at night. So pleased was he with the result that he had color-corrected light installed all through his house and was, the last time that we talked with him, contemplating having it installed in his printing plant, stating that what had given him so great a benefit would, he thought, be good for his employees.

Complete correction for color involves a heavy loss of light. It is well, therefore, for the examiner to be provided with filters giving different amounts of correction for color in order to meet the requirements of different eyes and different lighting conditions. Filters suggested are the Daylight and Whiterlite glasses furnished by the Macbeth Day-

lighting Company, etched to give the required amount of diffusion. The Daylight glass used as a corrective of Mazda light gives a color approximating that of an overcast sky. In the scale of color temperatures this may be specified as about 6,500 K. (Kelvin). This color temperature has been adopted by the Bureau of Standards as best for work with color. The color temperature of Mazda light filtered through the Whiterlite filter may be specified as around 5,500 K., depending on the wattage of the lamp. Some benefit may be had by the use of the Celestialite glassware furnished by the Gleason-Tiebout Glass Company. Filtered through this glass Mazda light is relieved of a great deal of the yellow quality that is so distressing to some eyes and to some extent objectionable to all eyes. This glass gives a high transmission of light which makes it feasible for use in all commercial lighting. A further advantage is its high coefficient of diffusion. This glass may be added, if desired, to the test filters already recommended.

In selecting the color filter great care should be taken that the filtered light obtained has a proportion of wavelengths well balanced with respect to the welfare of the eye, such as is the case with the two types of glass supplied by the Macbeth Daylighting Company. Not every blue glass can be used to advantage as a filter for Mazda light. On examination with the spectrophotometer the blue bulb of commerce, for example, shows an excess of light in the green part of the spectrum. Also, the glass used in making this bulb is not carefully standardized; that is, it is variable in its filtering properties. Tests made by us for ocular fatigue and discomfort with this lamp gave a poorer result than that of tests made with unfiltered Mazda light.

For one who really needs light-prescribing for color little more is required in the way of a test than to give him a chance to read or work under color-corrected light. For him the benefit of color correction is so great that there is no doubt as to the preference. Hôwever, if a more exacting test is desired, the test for the preferred intensity and the range of toleration of intensity can be made for both corrected and uncorrected light. Thus the range of intensities used affords the observer ample opportunity to judge which gives the better results. Or the comparison can be made at equal intensities, for example, the preferred intensity for the uncorrected light or some other representative intensity. The test should be made with all light as nearly as possible excluded from the room except that which comes from the test instrument.

As a final comment on the merits of color-corrected light we may mention some results that we have recently obtained with an instrument which we devised in 1932. We have called this instrument a visibility comparator. Measurements made with it showed in general that given visibilities in Mazda light could be equaled by the use of a much lower

intensity of artificial daylight, the amount of this difference varying for a given observer with such factors as the level of the intensity used and the size of the print or other detail. In the current practice of lighting the tendency has been to try to increase visibility by increasing the intensity of the light alone. In this practice a serious difficulty is encountered in the glare and ocular discomfort that are apt to be caused by the use of these higher intensities. In the case of many eyes this difficulty is serious and often arises in those cases in which increase of visibility is most neded. In this connection the great effectiveness of color-corrected light for increasing visibility should not be overlooked. In fact, the best conditions for clear and comfortable seeing must include an optimum combination of intensity of light, color of light and size of detail. We particularly feel the need of stressing the importance of the factor of correctness of color. From the standpoint of the welfare of the eye there is everything to be said for this factor and nothing against it.

In case the examiner should want to test the preference of the patient with reference to any of the tinted lenses that are sometimes prescribed either or both of the aforementioned procedures should serve this purpose well. Particularly the test for the preferred intensity and the range of toleration for intensity with both the tinted lens and the neutral lens should give as good an opportunity for making the comparison as can readily be had in a test procedure. In the case of tinted lenses it should perhaps be expected that the benefit, when present, would be largely in terms of comfort rather than visibility. Quantitative tests for visibility are therefore apt to be disappointing. The test can be made, of course, with both artificial light and color-corrected light. It would be expected, however, that the need for the test would be greater with artificial light.

INTENSITY OF LIGHT AND STRENGTH OF READING GLASSES

In any series of tests which is carried out as a basis for the prescribing of the intensity of light it will be found that the major need for individual testing is for the adolescent, the sick and the defective and for persons with presbyopic or with near-presbyopic eyes. There is much less need for individual testing of normal eyes of persons between the ages of 20 and 35 years. We have found that the greater number of these eyes prefer a medium intensity of light over a comparatively small range. In case of the presbyopic eye the greatest benefit from the test may be had for eyes in the early and middle stages of presbyopia. These comments are based on the results of the study of eyes of persons of different ages, noted earlier in the paper.

There are two means of aiding the presbyopic eye to see an object at the desired near distance, namely, a correcting glass and intensity of light. The former of these is the major aid, and the latter, a minor or auxiliary aid. However, the proper selection of either cannot be made without reference to the other. The preferred procedure is the selection of the optimum combination of intensity of light and strength of glass.

So far as the correcting glass is concerned it may be said that the strength of the glass required at a given near distance sustains, within comparatively narrow but significant limits, an inverse relation to the intensity of the light used. At high intensities the work can be discriminated with a weaker glass than at medium and low intensities. This is due for the greater part, if not entirely, to the effect of the higher intensities of light on acuity and the visibility of the object. At medium and low intensities stronger glasses are needed. Through this range, however, there is less effect of change of intensity on the preferred strength of glass—little, in fact, until very low illuminations are reached. At these intensities the tendency is to choose a still stronger glass in order to secure a benefit from magnification. This glass, however, would not in most cases be satisfactory at medium and high intensities without changing the distance of the work, and probably not even then, because of the greater amount of convergence required, the less favorable relation between accommodation and convergence and the undue limitation of the range of distance over which the object can be discriminated. At these intensities the additional magnification is not needed for the comfortable discrimination of the object.

It cannot be too strongly urged that due attention be given to both the intensity of the light and the strength of the glass in prescribing the conditions of seeing for the presbyopic eye. Often too strong glasses are prescribed because too low an intensity of light has been used in making the examination; and, conversely, frequently too high an intensity of light is advised or required because the person is wearing too weak a glass, in which case he may be compelled for the sake of adequate visibility to work above his threshold of glare. A fuller discussion of this topic with illustrative data has been given in a previous paper.[10] Only enough is given here to indicate its relation to the general subject.

SUMMARY

In comparison with other branches of medicine the development and use of hygienic measures in the care and treatment of the eye seem to have suffered retardation, perhaps unduly so. The subject of hygiene has been built up in the attempt to preserve and restore normality

10. Ferree, C. E., and Rand, G.: The Use of Variable Illumination in the Correction of the Presbyopic Eye, Am. J. Ophth. **19**:238 (March) 1936.

of function through the regulation of the conditions under which the organ functions. Like any other organ of the body, the eye, if it is to remain healthy or to cure itself of any of its ills, congenital or acquired, must first be put into a situation calling only for the healthy exercise of its normal functions. Important factors in this situation are the conditions under which it is ordinarily called on to work, two important aspects of which are the type of work and its illumination. Of these aspects the latter is the more amenable to variation and control. Radical changes cannot be made in the work itself, although some improvement in this direction may come with time. Obviously the lighting of the work is the more promising and the more important angle of attack.

For more than twenty years we have studied lighting in relation to the eye. The results obtained and the principles discovered, however, belong essentially to the general subject of lighting. They are not sufficiently specific to be of direct and significant service to the physician. For him the subject of lighting narrows down primarily to what is needed for the individual patient who comes under his care. For the determination of this special tests which can be easily and conveniently made are needed. The next step is to see that what is needed can be obtained; in short, the prescription must be filled. In later years we have devoted a great deal of our work in lighting to those ends. Means and methods of testing have been devised which cover the more important aspects of lighting, and with them we have studied the characteristics and variability of individual needs in both nonpathologic and pathologic conditions. Lighting equipment of sufficient range and flexibility to meet individual requirements has also been devised, and a great deal of time has been spent in making it available to the public. Thus a new division of the subject of lighting has been created which belongs in its narrower and more technical aspects to the medical profession and in its broader and more general aspects to the welfare and personnel worker. The prescribing of light to meet the requirements of the individual person has become a practical possibility, and we strongly believe that when properly used it will be of significant service in the care and treatment of the eye. The need for it is acute in the case of many of the patients who come under the physician's care.

GROWTH IN MASS AND VOLUME OF THE HUMAN LENS IN POSTNATAL LIFE

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MINNEAPOLIS

The postnatal growth in mass and volume of the human lens is different from that of most structures associated with the nervous system. Examination of the available published data has yielded records of the weights and volumes of approximately 230 fresh and presumably normal human lenses, and we have been able to supplement these with records of the weight of the lens in ten full term new-born children.[1]

These data are sufficient to permit tracing a curve for the postnatal growth of the lens and the computation of certain constants. They are not sufficiently extensive to warrant analytic treatment of the records for subjects in the first decade.

GROWTH OF THE LENS IN WEIGHT

Tables 1, 2 and 3 and figures 1 and 2 illustrate the growth of the lens in mass. The lens has a mean weight of almost 66 mg. at birth. This weight is increased about one-half in the first six months, almost

From the Graduate School and the Institute of Child Welfare, the University of Minnesota.

1. Becker, O.: Zur Anatomie der gesunden und kranken Linse, Wiesbaden, J. F. Bergmann, 1883. Clapp, C. A.: A Communication on Infant Lenses and Their Solids, Arch. Ophth. **42**:618, 1913. Collins, W. J.: Lectures on the Anatomy and Pathology of the Eye, Lancet **2**:1329, 1894; An Address on the Crystalline Lens in Health and in Cataract, Brit. M. J. **2**:1440, 1905. Deutschmann, R.: Fortgesetzte Untersuchungen zur Pathogenese der Cataracte: II. Cataracta senilis, Arch. f. Ophth. **25**:213, 1879. Engel, J.: Ein Beitrag zur Physik des Auges, Vrtljschr. f. prakt. Heilk. **7**:167, 1850. Heine, L.: Beiträge zur Physiologie und Pathologie der Linse, Arch. f. Ophth. **46**:525, 1898. von Jaeger, E.: Ueber die Einstellung des dioptrischen Apparates im menschlichen Auge, Vienna, L. W. Seidel & Sohn, 1861. Smith, P.: The Growth of the Crystalline Lens, Brit. M. J. **1**:112, 1883; On the Growth of the Crystalline Lens, Tr. Ophth. Soc. U. Kingdom **3**:79, 1883; On the Pathology and Treatment of Glaucoma, London, J. & A. Churchill, 1891. The studies of von Jaeger and others have shown how important it is to determine the weight of the lens as soon as possible after death. The lens begins to absorb water from the surrounding tissues within a short time post mortem. An attempt has been made to eliminate weights that were taken after this postmortem change became effective.

doubled in the first year after birth and increased more than twofold in the early part of the first decade. Thereafter the scheme of growth seems to undergo a marked change, and the increase in the weight of the lens is roughly proportional to age until late senility. At 35 years of age the weight of the lens is approximately three times the weight at birth, and at 75 years it approaches four times the weight at birth.

TABLE 1.—*Weight and Volume of the Human Lens in Postnatal Life* *

Age		Weight of Lens			Volume of Lens		
Range	Median	Number of Lenses	Mean and Probable Error, Mg.	Coefficient of Variation, Percentage	Number of Lenses	Mean and Probable Error, Cu.Mm.	Coefficient of Variation, Percentage
Birth	.....	10	65.6 ± 1.9	13.7	..	.....	....
1 to 3 months	2 months	24	92.8 ± 1.2	9.6	..	.....	....
4 to 5 months	4.5 months	4	109.0 ± 6.1	16.6	..	.....	....
10 to 11 months	10.5 months	2	124.5	....	..	.....	....
1 to 10 years	8 years	1	146.8	....	..	.....	....
10 to 20 years	17.5 years	6	152.8 ± 2.1	9.0	..	.....	....
20 to 30 years	25 years	24	172.0 ± 2.0	9.7	21	162.9 ± 1.8	7.2
30 to 40 years	35 years	31	190.3 ± 1.5	6.4	22	177.3 ± 1.7	6.5
40 to 50 years	45 years	34	202.4 ± 1.9	8.1	23	188.1 ± 2.1	7.9
50 to 60 years	55 years	25	222.3 ± 2.5	8.2	22	205.4 ± 2.7	8.8
60 to 70 years	65 years	41	230.1 ± 3.1	12.8	32	213.0 ± 3.0	11.8
70 to 80 years	75 years	22	237.1 ± 3.4	9.8	21	218.3 ± 2.9	8.8
80 to 90 years	85 years	15	258.1 ± 2.8	6.2	15	238.7 ± 3.0	7.0

* All the values were calculated to the third and thrown to the first decimal.

TABLE 2.—*Observed and Calculated Weight of the Human Lens at Ages from 10 to 90 Years* *

Age, Years				Residuals†		Calculated at Decades	
Range	Median	Observed (a), Mg.	Calculated (b), Mg.	Absolute ($a-b$), Mg.	Relative $\left(\frac{a-b}{a}\times 100\right)$, Percentage	Age, Years	Weight of Lens Mg.
10 to 20	17.5	152.8	161.4	−8.6	−5.6	10‡	151.7
20 to 30	25	172.0	172.8	−0.8	−0.5	20	166.0
30 to 40	35	190.3	187.1	+3.2	+1.7	30	180.3
40 to 50	45	202.4	201.4	+1.0	+0.5	40	194.6
50 to 60	55	222.3	215.7	+6.6	+3.0	50	208.9
60 to 70	65	230.1	230.0	+0.1	±0.0	60	223.2
70 to 80	75	237.1	244.3	−7.2	−3.0	70	237.5
80 to 90	85	258.1	258.6	−0.5	−0.2	80	251.8
						90‡	266.1

* Empirically expressed, the weight of the lens equals 137.45 mg. plus 1.429 years (age).
† The mean unweighted absolute residual of calculated from observed values, taken without regard to sign, was 3.5 mg. The mean unweighted relative residual of calculated from observed values, taken without regard to sign, was 1.8 per cent.
‡ Extrapolated.

The data that we have collated show sufficient constancy in trend to warrant their expression by an empirical formula for a straight line:

$$LW = 137.115 \text{ mg.} + 1.429\,A,$$

in which LW is the weight of the lens in milligrams and A is the age in years. This expression was obtained by fitting, by the method of

averages, the mean weight for each decade at the median point of the decade. The mean values were weighted by the square root of the number of observations included. The calculated figures show an unusually close approximation to the observed values for biologic data of this nature. Table 2 and the upper curve in figure 2 present the results in detail.

The variability of the material is indicated by the coefficient of variation (shown in the fifth column of table 1). This is irregular and is higher than that found for most measurements of the structures asso-

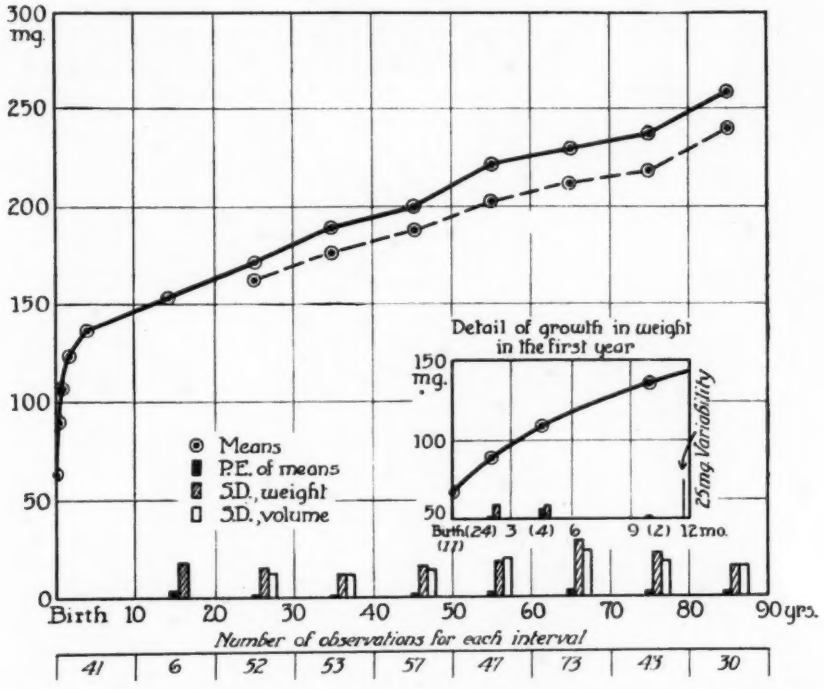

Fig. 1.—Curves showing the growth of the lens in weight from birth (unbroken line) to 90 years and the growth in volume in cubic millimeters (broken line) from 20 to 90 years. The curve for the weight of the lens in the first decade was drawn from inspection. The curves for the weight of the lens and the volume of the lens from 25 years up were drawn by connecting mean points. The inset shows the growth of the lens in weight in the first year; this curve was drawn from inspection. P. E. indicates probable error, and S. D., standard deviation.

ciated with the nervous system but is somewhat below that for most other organs and parts of the body. It seems probable that this apparent variability is increased by the length of the intervals employed and perhaps by experimental error in weighing the lenses.

GROWTH OF LENS IN VOLUME

We have found no reliable data on the growth of the lens in volume in the first two decades, but we have collated 186 observations on the volume of older and presumably normal lenses.[2] These are shown in the last two columns of table 1 and in table 3 and are presented graphically in figures 1 and 2.

The volume of the lens in persons from 20 to 90 years of age increases at a steady rate which, like the weight of the lens, is proportional to age. In the middle of the third decade the mean volume of the lens is, roughly, 163 cu. mm., and this volume is increased about one third by the time extreme old age is reached.

TABLE 3.—*Observed and Calculated Volume of the Human Lens at Ages from 20 to 90 Years* *

Age, Years		Observed (a), Cu.Mm.	Calculated (b), Cu.Mm.	Residuals†		Calculated at Decades	
				Absolute ($a-b$), Cu.Mm.	Relative ($\frac{a-b}{a} \times 100$), Percentage	Age, Years	Volume of Lens, Cu.Mm.
Range	Median						
20 to 30	25	162.9	166.3	−3.4	−2.1	20‡	160.6
30 to 40	35	177.3	177.7	−0.4	−0.2	30	172.0
40 to 50	45	188.1	189.1	−1.0	−0.5	40	183.4
50 to 60	55	205.4	200.5	+4.9	+2.4	50	194.8
60 to 70	65	213.0	211.9	+1.1	+0.5	60	206.2
70 to 80	75	218.3	223.3	−5.0	−2.3	70	217.6
80 to 90	85	238.7	234.7	+4.0	+1.7	80	229.0
						90‡	239.0

* Empirically expressed, the volume of the lens equals 137.8 cu.mm. plus 1.14 years (age).
† The mean unweighted absolute residual of calculated from observed values, taken without regard to sign, was 2.8 cu.mm. The mean unweighted relative residual of calculated from observed values, taken without regard to sign, was 1.4 per cent.
‡ Extrapolated.

As in the case of the weight of the lens, the relation between the volume of the lens and age may be expressed by a simple empirical formula representing a straight line:

$$LV = 137.80 \text{ cu. mm.} + 1.14\,A,$$

in which LV is the volume of the lens in cubic millimeters, and A is the age in years. The fit of this expression to the observed means is slightly better than the fit of the expression for the weight of the lens.

RELATION BETWEEN WEIGHT AND VOLUME OF THE LENS

A number of determinations of the specific gravity of the lens have been made, but since these were usually taken without controlled technic, were based on few observations and were without data on age,

2. Most of the data are from the sources cited in footnote 1.

the figures are variable. Thus, Davy [3] reported a mean value of 1.100. Nunneley [4] noted a value of 1.1304 for the lens of a young man, and values of 1.10909 and 1.10967, respectively, for the right and the left lens of an older woman. Chenevix [5] obtained a value of 1.079. We have computed the specific gravity for the lens from 20 years of age up from our calculated values as given in tables 2 and 3. Such a computation is not entirely trustworthy, for it is based on values arrived at by calculation, and the original values which form the basis of this procedure are averages. The resulting expression therefore approaches

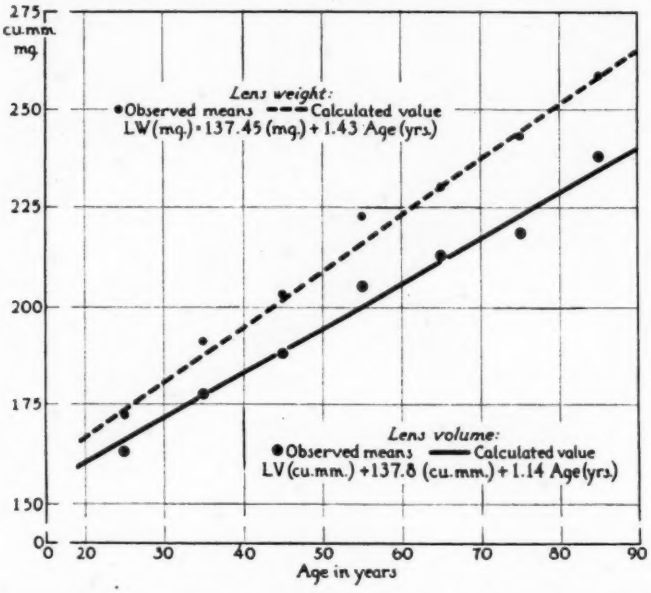

Fig. 2.—Growth of the lens in weight and volume from 20 to 90 years. The broken line indicates the calculated weight of the lens; the solid line, the calculated volume of the lens; the solid dots, the means (for decades) of the weight of the lens, and the circled dots, the means (for decades) of the volume of the lens. These schemata are based on the material given in tables 1, 2 and 3.

the mean of the sums of the ratios and not the average of the individual ratios. The expression is as follows:

$$Sp.\ Gr. = \frac{LW}{LV} \text{ or } \frac{a + bA}{c + dA}$$

in which *Sp. Gr.* is specific gravity, *LW* and *LV* are the weight of the lens and the volume of the lens, respectively, *A* is the age in years, and

3. Davy, J.: Tr. Med.-Chir. Soc. Edinburgh **3**:436, 1829.

4. Nunneley, T.: On the Form, Density and Structure of the Crystalline Lens, Quart. J. Micr. Sc. **6**:136, 1858.

5. Chenevix, quoted by Sappey, P. C.: Traité d'anatomie descriptive, ed. 3, Paris, V.-A. Delahaye, 1877, vol. 3, p. 807.

a, *b*, *c* and *d* are the constants given in the first and second formulas. The rate and relative rate of change in this index have been computed by differentiating and are shown in table 4 and figure 3.

TABLE 4.—*Calculated Specific Gravity of the Human Lens at Ages from 20 to 90 Years*

Age, Years	Calculated Specific Gravity*	Rate of Change in Calculated Specific Gravity	
		Absolute, Units per Decade	Relative, Percentage per Decade
20	1034	15.6	1.5
30	1048	13.6	1.3
40	1061	12.0	1.1
50	1072	10.6	1.0
60	1082	9.5	0.9
70	1091	8.5	0.8
80	1100	7.7	0.7
90	1113	7.0	0.6

* The usual specific gravity, which is a ratio, has been multiplied by 1,000, as is often done in physiologic studies, to avoid decimals.

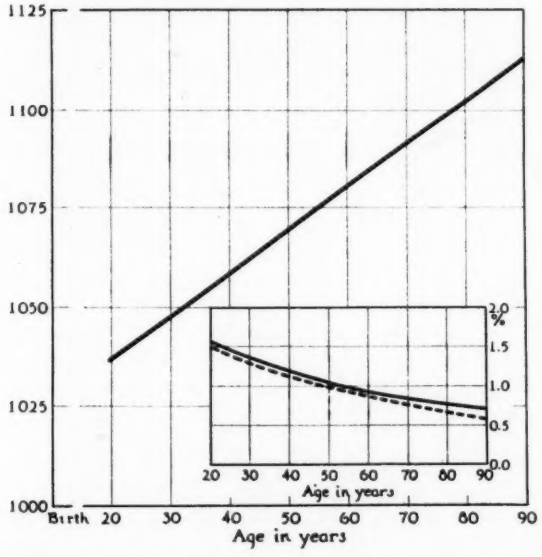

Fig. 3.—The curve in the main panel shows the computed specific gravity of the human lens from 20 to 90 years, inclusive. The curves in the minor panel show the absolute and the relative changes in the computed specific gravity of the lens. The solid curve indicates the rate of change per decade in terms of units; the broken curve, the change per decade in terms of percentage. The specific gravity has been multiplied by 1,000 to eliminate the use of decimals.

The calculated specific gravity is 1034 at 20 years of age, 1072 at 50 years and 1113 at 90 years. The absolute increase as well as the relative increase in specific gravity is much more rapid in the earlier years than in the later years, contrary to common opinion.

It is evident that while the weight of the lens in later years is increased somewhat, owing to its greater density, most of the change is due to the increase in bulk.

COMPARISON OF THE GROWTH OF THE LENS WITH THAT OF OTHER STRUCTURES OF OR ASSOCIATED WITH THE NERVOUS SYSTEM

It appears that the weight and probably the volume of the lens show a curious pattern of growth. In infancy and early childhood the growth follows the pattern common to most parts of both the central and the peripheral nervous system. But thereafter growth is continued at a steady rate, whereas most structures associated with the nervous system approach or reach their definitive size in the second decade.

TABLE 5.—*Ratios of Size of Sundry Structures Associated with the Nervous System at Approximately 3 Years and Approximately 20 Years of Age to Their Size at Birth*

Part	Ratio, Percentage: About 3 Years	Ratio, Percentage: About 20 Years	Comment
Encephalon (weight)	316	388	Calculated
Cerebrum (weight)	297	377	Calculated
Cerebellum (weight)	562	711	Calculated
Brain stem (weight)	350	526	Calculated
Spinal cord (weight)	440	900	Estimated
Peripheral nerves of upper extremity (weight)	403	1,530	Data of Heptner (Arch. f. Anat., 1915, p. 277)*
Internal ear (volume)	100	100	Determined from casts
Optic nerve (volume)	...	213	Computed from linear measurements†
Combined coats of the eyeball (volume)	...	700	Calculations of Scammon and Armstrong (J. Comp. Neurol. 38: 165, 1925)
Eyeball in toto (weight)	118	468	Derived from values on smoothed curve
Lens (weight)	222	253	Calculated

* The great relative postnatal increase in the size of the peripheral nerves is probably due in large measure to the growth of connective tissue and the deposition of fat.

† Scammon, R. E., and Armstrong, E. L.: J. Comp. Neurol. 38: 165, 1925; Ottersky, E.: Untersuchungen über Weichteile und Knochen der mittleren Schädelgrube inbesondere über die Lage des Chiasma opticum, Königsberg, R. Schenk, 1896.

The amount of postnatal growth of the lens (computed as a percentage ratio to the weight at birth) is also different from that of most other parts of the nervous system. This is illustrated in table 5, which gives the ratios of the size of a number of structures associated with the nervous system at about the age of 3 years and about the age of 20 years to the size at birth. While it is not thought that the ratios given in this table are entirely accurate, they seem to be substantially correct.

It will be seen that most parts associated with the nervous system have made a greater relative gain in the first three years of life than

the lens, although this is not true of the eyeball as a whole. At the age of 20 years all the structures listed, aside from the optic nerve and the internal ear, have made a larger relative gain than the lens. The optic parts as represented by the combined coats of the eye and the eyeball in toto show the same characteristics as the other structures associated with the nervous system. In the first two decades the lens is apparently a decreasing component of the eyeball. This is shown graphically in figure 4, which shows median sagittal sections of the eyeball with the lens, at 5 fetal (lunar) months, birth and early maturity, respectively. In order to make these schemata geometrically correct, the drawings have been reduced to the same area in each instance. After early maturity the lens must necessarily become an increasingly larger component of the eyeball, for all the present evidence indicates that the former structure continues to grow, while the latter remains stationary.

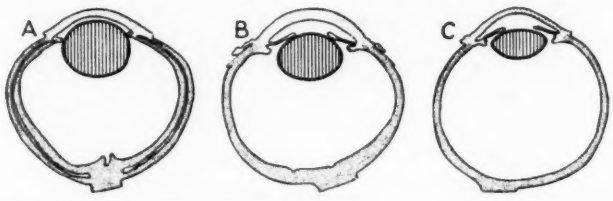

Fig. 4.—Outlines of median sagittal sections of the eye at three ages. *A*, section of the eye of a fetus of 5 lunar months (from Bach, L., and Seefelder, R.: Atlas zur Entwicklungsgeschichte des menschlichen Auges, Leipzig, W. Engelmann, 1914). *B*, section of the eye of a new-born infant (from Merkel, F., and Orr, A. W.: Das Auge des Neugeborenen an einem schematischen Durchschnitt erläutert, Anat. Hefte **1**:271, 1892). *C*, section of the eye of a young adult (from Merkel, F., and Kallius, E.: Makroskopische Anatomie, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, W. Engelmann, 1892, vol. 1, pt. 1, chap. 1). All the drawings have been reduced to equal areas to establish proportional dimensions.

COMPARISON OF THE GROWTH OF THE LENS WITH THAT OF OTHER STRUCTURES OF THE BODY EXCLUSIVE OF THE NERVOUS SYSTEM

Not only do structures associated with the nervous system cease to grow at a relatively early age, but also most other parts of the body make little gain or often regress in size after middle life. But it may be pointed out that at least two other structures also increase in size to extreme old age. These are the greater arteries, as determined by measurements either of the caliber or of the circumference, and the alveoli of the lungs, as determined by measurements of the diameter.

A considerable amount of data on the increase in caliber of the great arteries was collected by Beneke,[6] Thoma,[7] Suter,[8] Husten[9] and others, who all obtained substantially the same results.

The data on the diameter of the alveoli of the lungs were given in a thesis by Rossignol,[10] who found a continued increase in size from early infancy to senility. While the material was collected many years ago, it seems authentic.

It may be suggested that function in each of these organs is associated with elasticity, and that their increase in size, whether it is regarded as physiologic or pathologic, may be associated with the loss of this functional elasticity.

SUMMARY

The postnatal growth in mass and volume of the human lens shows two distinct phases. In infancy and early childhood the lens grows much like a number of other structures associated with the nervous system. After this early phase of rapid relative increment, the lens enters on a period of slow and steady growth, which (as evidenced by specimens selected by the best available criteria of normality) continues throughout the remainder of life. There seems to be no good evidence that increase in density is the major factor in this later growth in mass. It is suggested that the continued growth of the lens through middle age and old age may be associated with loss of elasticity in this structure.

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6. Beneke, F. W.: Die anatomischen Grundlagen der Constitutionsanomalien des Menschen, Marburg, N. G. Elwert, 1878.

7. Thoma, R.: Untersuchungen über die Grösse und das Gewicht der anatomischen Bestandtheile des menschlichen Körpers im gesunden und im kranken Zustande, Leipzig, F. C. W. Vogel, 1882; Untersuchungen über die Histogenese und Histomechanik des Gefäss-systems, Stuttgart, F. Enke, 1893.

8. Suter, F.: Ueber das Verhalten des Aortenumfanges unter physiologischen und pathologischen Bedingungen, Arch. f. exper. Path. u. Pharmakol. **39**:289, 1897.

9. Husten, K.: Anatomische und histologische Untersuchungen über Weite und Wand der Hohlvenen, Veröffentl. a. d. Kriegs- u. Konstitutionspath. **16**:1, 1926.

10. Rossignol: Recherches sur la structure intime du poumon de l'homme. Bruxelles, De Mortier frères, 1846.

OPSONIC INDEX FOR UVEAL PIGMENT IN TREATED PATIENTS

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This study was undertaken to determine the changes in the opsonic index in the blood serums of patients treated with uveal pigment. The rationale of this treatment has been fully described in various papers by A. C. Woods.[1] This author has shown that hypersensitivity to uveal pigment is a constant phenomenon in sympathetic ophthalmia and apparently paves the road for the outbreak of the disease, whatever other factors may initiate the process. Treatment with uveal pigment is designed to eradicate this hypersensitivity—to desensitize the patient. The clinical results of such treatments have been fully reported.[2] Likewise, there have been extensive studies on the antigenic properties of uveal pigment, demonstrating the organ specificity of this substance.[3] There have, however, been no studies on the mode of absorption of uveal pigment in man. It was to determine this point that this study was undertaken.

Opsonins for granules of uveal pigment seemed important because extensive phagocytosis of pigment had been noted on biopsy in the intracutaneous uveal pigment and in the uveal tract of patients with sympathetic ophthalmia.[4] Heat-stable opsonins for uveal pigment had never been demonstrated in human blood, though weak "normal" opsonins for beef pigment were demonstrated in normal human blood in 1908.[5] Heat-stable "melanopsonins" and complement-fixing bodies

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Woods, A. C.: Allergy in Its Relation to Sympathetic Ophthalmia, New York State J. Med. **36**:67 (Jan. 15) 1936.

2. Woods, A. C., and Knapp, A.: The Therapeutic Use of Uveal Pigment in Sympathetic Ophthalmia, Arch. Ophth. **51**:560, 1922. Woods, A. C.: Sympathetic Ophthalmia: The Use of Uveal Pigment in Diagnosis and Treatment, Tr. Ophth. Soc. U. Kingdom **45**:208, 1925.

3. Woods, A. C.: A Contribution to the Anaphylactic Theory of Sympathetic Ophthalmia, Arch. Ophth. **46**:8, 1917; Ocular Anaphylaxis: III. The Rôle of Uveal Pigment, ibid. **46**:283, 1917; IV. The Antigenic Properties of Uveal Tissue as Shown by Complement Fixation, ibid. **46**:503, 1917; V. Experimental Iridocyclitis, ibid. **47**:161, 1918.

4. Friedenwald, J. S.: Notes on the Allergy Theory of Sympathetic Ophthalmia, Am. J. Ophth. **17**:1008, 1934.

5. Shattock, S. G., and Dudgeon, L. S.: Observations on Phagocytosis Carried Out by Means of Melanin, Proc. Roy. Soc., London, s.B **80**:165, 1908.

had been produced in 1909 by injecting granules of melanin into guinea-pigs.[6] These melanopsonins were not studied further because in 1909 bacterial opsonins seemed of greater practical importance.[7] Apparently, the only "inert" substances ever injected to produce opsonins[8] were granules of melanin,[7] globules of milk[9] and erythrocytes.[10] The present study adds uveal pigment of man to the list.

TECHNIC

In determining the opsonic index the classic Wright technic was used first and then a modified technic with heparinized blood. All the determinations were checked by both methods. These technics are as follows:

1. *Wright Technic.*—To a good suspension of pigment 0.3 cc. of the serum to be tested and 0.3 cc. of washed cells from a normal patient were added by means of a Wright pipet which was equipped with a rubber bulb. Thorough mixing was accomplished by repeated expression of the contents on a warm watch glass. The mixture was sealed in the pipet and incubated at 37 C. for fifteen minutes. Then the mixing was repeated, and a smear was made according to Wright's technic. Fifty neutrophils were examined for phagocytosis of granules of pigment. The average number of granules of pigment phagocytosed by one neutrophil was recorded as the phagocytic index.

2. *Technic with the Use of Heparinized Blood.*—To a good suspension of pigment 0.6 cc. of the heparinized blood to be tested was added, in a Wassermann tube. The tube was tapped gently and then incubated fifteen minutes at 37 C. The tube was again tapped gently, and a smear was made according to Wright's technic. The phagocytic index was determined as with Wright's technic.

MATERIAL FOR STUDY

The heparinized blood and the blood serum of treated patients were obtained from J. M., a white boy aged 14 who had sympathetic ophthalmia, and M. H., a white man aged 24 who also had sympathetic ophthalmia (patients 1 and 2).

The heparinized blood and the blood serum from patients not receiving pigment therapy were obtained from patients with a variety of ocular conditions for which various kinds of treatment had been given.

RESULTS

1. *Increase in the Opsonic Index.*—The blood serum of patient 2 showed the following increase in the opsonic index for pigment: Before

6. Ledingham, J. C. G.: Phagocytosis of So-Called Neutral Substances, Ztschr. f. Immunitätsforsch. u. exper. Therap. **3**:119, 1909.

7. Knapp, A.: On the Occurrence of Opsonins in the Aqueous Humor, Arch. Ophth. **38**:372, 1909.

8. Muir, R.: A System of Bacteriology, Medical Research Council, London, His Majesty's Stationery Office, 1931, vol. 6, p. 365.

9. Neufeld, F., and Händel: Beiträge zur Kenntnis der Wirkungverschiedener blutösender Gifte, insbesondere des taurocholsauren Natriums und der Seifs, Arb. a. d. k. Gsndhtsamte. **28**:572, 1908.

10. Hektoen, L.: On the Specificity of Opsonins in Normal Serum, J. Infect. Dis. **5**:249, 1908.

therapy was begun the index ranged between 4 and 8. After therapy was begun the indexes were 24 in the third week of therapy, 40 in the fourth week and 45 in the twelfth week. The complement fixation reaction for beef pigment changed from negative to strongly positive before the sixth week of therapy. Simultaneous tests made with a variety of control serums showed indexes between 4 and 8 and negative complement fixation reactions. Biopsies of intracutaneous pigment indicated that the hypersensitivity to uveal pigment was greatest after the first three weeks of therapy and that it was only moderate in the twelfth week of pigment therapy. A control test with intracutaneous india ink was, of course, negative.

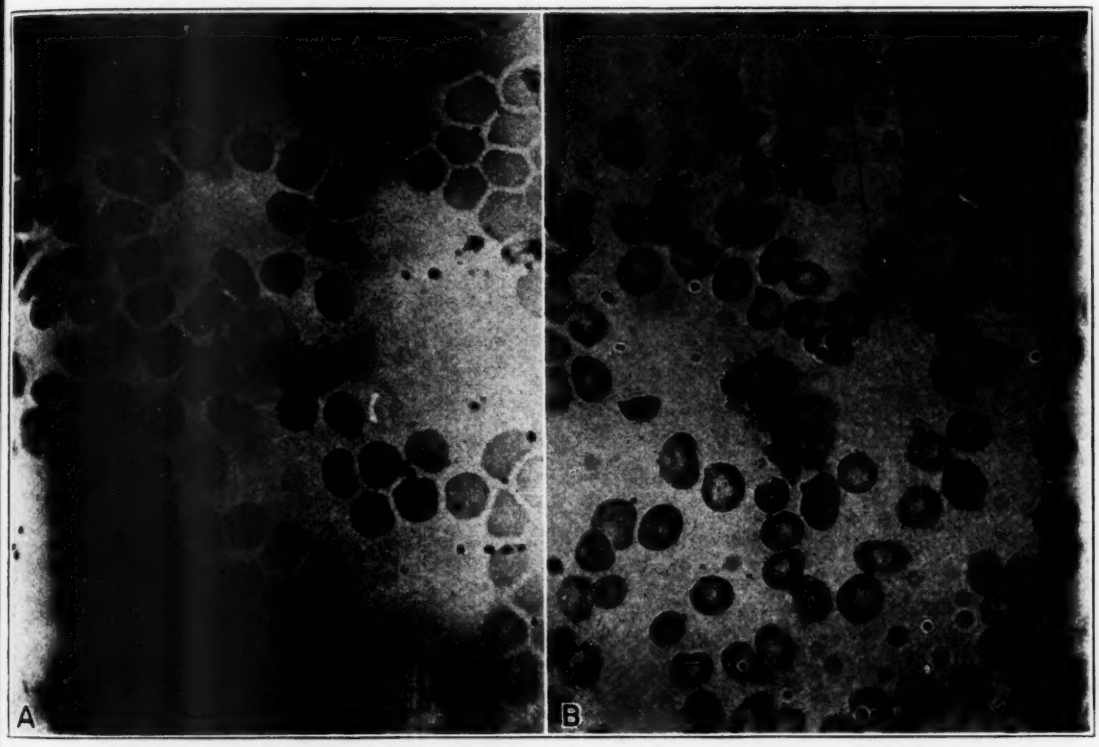

Fig. 1.—*A*, photomicrograph showing the influence of the serum of an untreated patient on the phagocytosis of pigment (human); *B*, photomicrograph showing the influence of the serum of a treated patient on the phagocytosis of pigment (human).

Patient 1 showed an index of about 45 for beef pigment during the last nine months of pigment therapy. He was followed for nine months after all therapy was stopped, and the index for beef pigment did not drop below 40. Intracutaneous tests showed that he was hypersensitive to pigment before therapy was begun but that he was not sensitive to pigment when therapy was stopped.

2. *Further Proof of the Organ Specificity of Pigment.*—In patients 1 and 2 beef pigment was used for the therapeutic injections. The opsonic index was determined not only for beef pigment but likewise for pork and human pigment. The therapeutic injections of beef pigment caused not only the increase in the index for beef pigment but an equal increase in the index for pork and human pigment.

Before pigment therapy was begun patient 2 showed indexes ranging between 4 and 8 for granules of beef, pork and human pigment when controlled tests were made simultaneously. In the twelfth week of therapy the indexes were 45 for beef pigment, 35 for pork pigment and 35 for human pigment. Another proof of the organ specificity of pigment was the marked phagocytosis noted in the biopsies of intracutaneous beef pigment and in biopsy of a prolapsed iris in this case. Extensive phagocytosis by epithelioid cells was prominent with the granules of beef pigment in the congested skin and with granules of human pigment in the prolapsed iris.

Nine months after pigment therapy was stopped patient 1 showed indexes of 40 for beef pigment and 30 for human pigment, in controlled tests carried out simultaneously. Since beef pigment was used in all the therapy, these findings were strong proof of the organ specificity of pigment. Control tests of patients not receiving pigment therapy uniformly gave indexes ranging between 4 and 8. The patients receiving milk therapy showed indexes above 6 for globules of milk, whereas all the other controls and patients 1 and 2 showed indexes below 2.

It was feared that the prozone phenomenon might invalidate the results obtained with the method in which heparinized blood was used. However, Wright's technic was used repeatedly with serum dilutions, and the prozone phenomenon could not be elicited.

To determine the heat-stable nature of the opsonins the following test was made with the serum of a patient treated with uveal pigment: The serum of this patient was heated at 56 C. for thirty minutes; normal complement was added, and the opsonic index for beef pigment was determined, by Wright's technic, to be 38. Control serums treated in the same fashion with heat and the addition of complement gave indexes below 4. The patient's serum showed an index of 42 when it was not heated and when complement was not added. The control serums showed indexes ranging between 4 and 8 when they were not heated and when complement was not added.

CONCLUSIONS

There is a unique increase in the opsonic index for uveal pigment in patients receiving pigment therapy.

The results obtained offer further proof of the organ specificity of pigment.

IS TRACHOMA A RICKETTSIAL DISEASE?

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TRANSLATED BY PHILLIPS THYGESON, M.D., NEW YORK

Researches on the etiology of trachoma have so often raised false hopes of a solution of the problem that the ophthalmologist has become suspicious of new ideas. The investigator himself, if he is able to criticize his own researches, always finds some reason to question his results.

It is for this reason that I have placed a question mark after the title of this paper. Even if the recent experiments of Cuénod and Nataf [1] have confirmed the existence of the minute bodies which I described in 1933 in trachomatous tissues, particularly in the follicles, their nature and their rôle in the etiology of trachoma require still further study.

As a result of my researches,[2] which have recently been confirmed by Cuénod and Nataf, one sees looming on the obscure horizon of the etiology of trachoma a new category of germs, the rickettsias. Further investigations will tell whether the etiologic relation of these organisms to trachoma is a discovery or simply an invention.

In 1933 I reported before the Fourteenth Congress of Ophthalmology, held at Madrid,[3] that I had observed in histologic sections and in smears of trachomatous material from the eyes of human beings bodies which by reason of their morphologic features and staining reactions I classified as rickettsias and to which I attributed a rôle in the etiology of trachoma. I arrived at this conclusion after many years of observation.

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1. Cuénod, A.: Note préliminaire sur la présence d'éléments infra-microbiens dans les follicules trachomateux, Arch. d'opht. **52**:145 (March) 1935. Cuénod, A., and Nataf, R.: Deuxième note sur la présence d'éléments infra-microbiens dans les follicules trachomateux, ibid. **52**:573 (Aug.) 1935; Troisième note sur l'agent bactérien du trachome, ibid. **53**:218 (March) 1936.

2. Busacca, A.: (*a*) Ueber das Vorhandensein von Rickettsien-ähnlichen Körperchen in den trachomatösen Geweben und über das Vorkommen von spezifischen Veränderungen in Organen von mit Trachom-Virus geimpften Tieren, Arch. f. Ophth. **133**:41, 1934; (*b*) Un germe aux caractères de Rickettsies (Rickettsia trachomæ) dans les tissus trachomateux, Arch. d'opht. **52**:567, 1935.

3. Busacca, A.: Sulla presenza di germi simili a Rickettsie nei tessuti tracomatosi, Klin. Monatsbl. f. Augenh. **91**:277, 1933.

As early as 1925, in fact, when I was working at Bologna, I saw these bodies when staining trachomatous follicles according to the method of Jahnel for the demonstration of spirochetes in nerve tissues. But the little experience I had had at that time in the interpretation of preparations of this type and the criticisms of "official science" determined me to consider the results of these researches as negative and to place my observations "in quarantine."

I took up these studies again in 1931 in Brazil, where I had abundant pure material at my disposal. After applying the methods of silver impregnation in staining fragments of material from the eyes of patients with trachomatous pannus I observed in cases of successful impregnation the same bodies which I had seen in preparations of conjunctival material made in Italy.

The small size of these organisms and the frequent occurrence of dumb-bell-like forms did not permit them to be classified among the already known bacteria, but when I saw the figures illustrating the chapter on rickettsias by Rocha Lima in Kolle and Wasserman's "Handbuch der pathologischen Mikroorganismen" I was struck by the great morphologic resemblance between the rickettsias and the bodies which I had observed, and I continued my researches in this direction.

I tried to see whether by the methods appropriate for the demonstration of rickettsias one could not also stain these bodies that occurred in trachomatous tissues. After applying to smears and to histologic sections of tissues stains according to the method of Giemsa, of Castenada, of Lépine and of others I have been able to demonstrate them with great constancy. With a single exception they have been absent in the controls. This exception was a case in which I observed comparable bodies in the smears of material from a lymph gland of a patient with Hodgkin's disease.

The rickettsia-like bodies appear as small granules, round or slightly elongated, sometimes isolated, sometimes joined in dumb-bell form and sometimes in masses.

The characteristic dumb-bell form (all the stains do not permit one to see the small segment which unites the two granules) has a length varying from 0.5 to 0.8 micron and a width of approximately 0.2 micron.

I work with impression smears. After excising with the scissors, in the region of the upper fornix, a fragment of conjunctiva rich in follicles, I hold the piece with a forceps and proceed to make light impressions on the slide; when the fragment leaves no more material I crush it a little between the arms of the forceps and continue the procedure.

The smears so obtained show some zones which are too thick and not utilizable, but, on the other hand, this technic offers the great

advantage of avoiding the rupture of a large number of nuclei and permits the study of cells of the deeper layers, which are present rarely in scrapings.

In the smears the bodies are stained violet-red by the Giemsa stain at p_H 7.2, blue by the method of Lépine and of Castenada, and blue by the victoria blue stain according to the method of Muehlpfordt, Kiel and van der Gerge. Last year I obtained some beautiful results by applying Herzberg's victoria blue method for the demonstration of viruses,[4] and I am of the opinion that for rapidity, simplicity and sharpness of the images obtained this method can be employed as a routine for diagnosis. With it one can easily see around the rickettsias a

Fig. 1.—Epithelial cells with numerous rickettsias in the protoplasm; smear stained with victoria blue; × 1,410.

minute halo, not always demonstrable by the other methods, and can note in a single cell certain differences in size and staining reactions among the rickettsias. Often it is possible to see masses which may represent multiplication forms.

The bodies are seen in epithelial cells, in cells of the follicle or even in a free state between the cells. In the cells they are sometimes scattered and sometimes grouped; occasionally they may fill the cell completely.

The free forms are not always identifiable and cannot be considered of great significance, but when they appear as small agglomerations

4. Busacca, A.: Méthode simple et rapide au bleu victoria pour la démonstration des rickettsies du trachome, Folia clin. et biol. **7**:253, 1935.

between the lymphocytes they may be recognized easily; between the epithelial cells they often form short filaments.

In histologic sections the demonstration of the rickettsias is more difficult. The method of Jahnel and the victoria blue stain, however, give beautiful preparations. Since the publication of my work I have also succeeded, in sections stained by the Giemsa stain, in staining the rickettsias red by adding some colophene to the alcohols used for differentiation. Some intracellular and some extracellular forms occur in the epithelium and in the tissues of the follicle. In the most superficial layers of the corneal epithelium one often sees cavities filled by bodies which, according to the stain employed, appear as very fine

Fig. 2.—Corneal epithelium in which the basal cells contain rickettsias; histologic section prepared according to the method of Jahnel; × 1,410.

granules or as a network of light threads along which darker granules are disposed. In certain cases the method of Jahnel shows ring forms.

The staining characteristics of these bodies may be summarized as follows:

In smears they stain violet-red with the Giemsa stain at p_H 7.2, light blue with the method of Castenada, blue with the method of Lépine, blue with victoria blue according to the method of Muehlpfordt, Keil and van der Gerge, and shades varying from blue to violet-blue with Herzberg's victoria blue stain.

In sections they stain red with the Giemsa stain, red or violet-red with Mann's method, deep blue with victoria blue, and light red after

prolonged staining with eosin and differentiation. They are very pale when stained with iron hematoxylin.

The morphologic features and the staining properties are thus seen to correspond to those of the rickettsias.

In a report published in 1934 Thygeson [5] attributed the characteristics of rickettsias to the elementary corpuscles of the Prowazek bodies; furthermore, like the majority of authors, he stated that he had never encountered them in the cells of the follicles but had seen them only in the epithelium. In the course of my researches I have always had the impression that the bodies which I have described differed from the elementary bodies. The examination of smears sent me by Thygeson has confirmed my opinion on this point, and Thygeson has concurred in it after examining the smears which I sent him. He

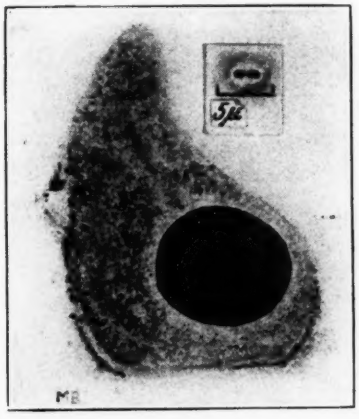

Fig. 3.—Epithelial cell with rickettsias scattered in the protoplasm; smear stained with the Giemsa stain; × 1,410.

observed the bodies which I described also in cases of trachoma in North America, but he has stated that he is not sure of their rickettsial nature and thinks that sufficient reasons have not been advanced to enable one to conclude that they are living organisms.[6]

Very interesting, according to my point of view, are the observations published by Cuénod and Nataf,[1] in which these authors referred to the presence of rickettsia-like bodies in smears from the contents of trachomatous follicles and in histologic sections from these follicles. The description which figured in the transactions of the Fourteenth International Congress of Ophthalmology, held at Madrid, and the iconographic documentation which I have given in publishing a com-

5. Thygeson, P.: The Nature of the Elementary and Initial Bodies of Trachoma, Arch. Ophth. **12**:307 (Sept.) 1934.

6. Thygeson, P.: Personal communication to the author.

plete account of my researches leave no doubt of the identity of that which I have observed and of that which Cuénod and Nataf have described. These authors have, in addition, clearly recognized in their reports the priority of my observations.

The use of appropriate methods (such as the cyanochine method) for obtaining negative images has made it possible for Cuénod and Nataf to evaluate the large numbers of bodies scattered in the smears; their interpretation remains doubtful when other methods are used. But these authors have succeeded in extending their observations beyond the morphologic field and recently reported some experimental researches [7] the results of which, if they are confirmed, will show clearly

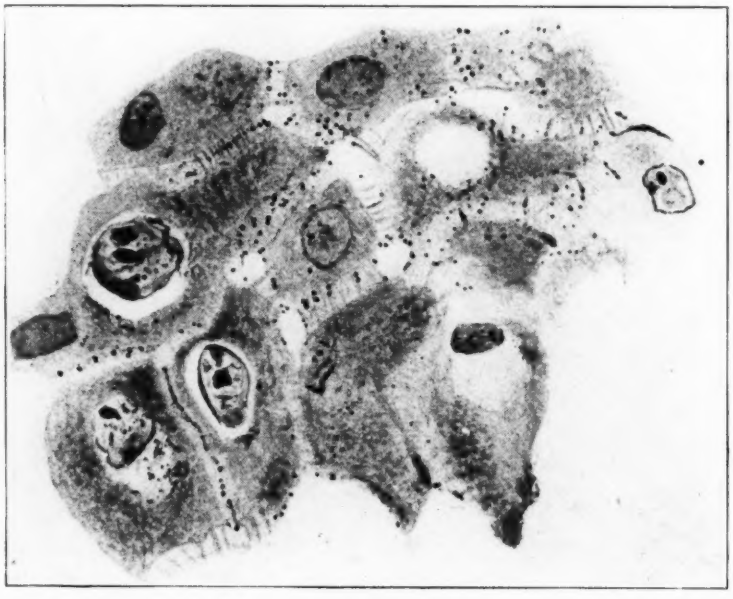

Fig. 4.—Epithelial cells of a cornea affected with pannus, showing intracellular and intercellular rickettsias; histologic section stained with the Giemsa stain; × 1,410.

the nature and rôle of these bodies. After inoculating some trachomatous material into the louse they observed in the epithelial cells of the intestine of these insects rickettsia-like bodies absolutely identical with those observed in the cells of the trachomatous follicles which they studied, and by the inoculation of material from infected lice they have been able to reproduce in the monkey a form of conjunctivitis having the characteristics of experimental trachoma.

7. Cuénod, A., and Nataf, R.: Nouvelles recherches sur le trachome: IV. Recherches expérimentales, Arch. d'opht. **53**:335, 1936.

The demonstration of these bodies is not easy, and Cuénod and Nataf have expressed the opinion that perhaps "because of inability easily to demonstrate them their existence will not be accepted." I believe that staining fresh smears with victoria blue according to the method of Herzberg is the simplest means of demonstrating them, but this stain is no more specific than the other stains, and I fear very much that the difficulties of demonstration may lead to false interpretations, as has occurred in connection with the Prowazek bodies.

EXPERIMENTAL RESEARCHES

In an attempt to give experimental confirmation to my observations I have tried the inoculation of trachomatous material into various

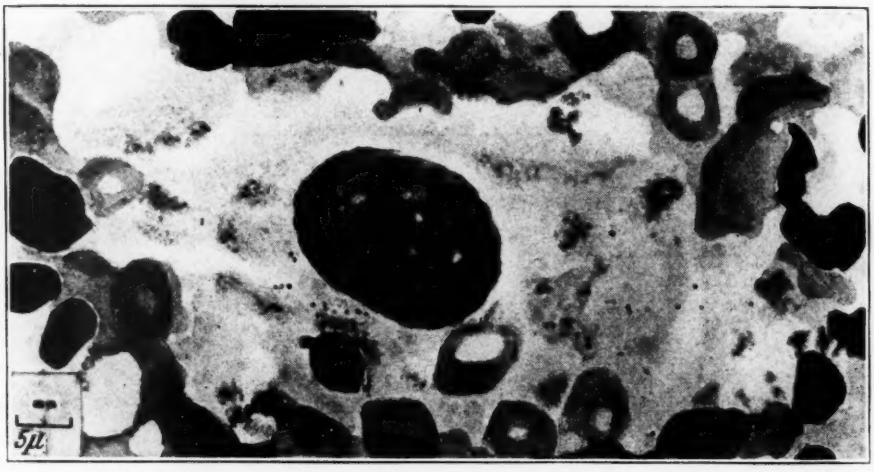

Fig. 5.—Large mononuclear cell of a trachoma follicle; few rickettsias are seen in the protoplasm; smear stained with the Giemsa stain; × 1,410.

organs (testicle, brain, spleen, lymph gland, vitreous body and anterior chamber of the eye) of the guinea-pig, the rabbit and the white mouse.[8]

In the testicle of the guinea-pig I obtained some reactions which I considered specific: In the cells of the vaginal sheath of the testicle I observed some rickettsia-like bodies. By intravitreous inoculation I also obtained some reactions which I at first considered specific but on the interpretation of which I was later led to modify my opinion. With the exception of the one case already cited I never have succeeded in demonstrating the rickettsia-like bodies either in the eyes or in any of the other inoculated organs.

While pursuing my researches with intravitreous inoculation I had observed in the chicken the formation of intra-ocular lymphatic nodules

8. Footnotes 2a and 3.

when von Szily [9] wrote (in January 1935) that he had obtained, as a result of intravitreous inoculation of an emulsion of trachomatous conjunctiva, the formation of follicles, which he believed to be trachomatous, in the interior of rabbits' eyes atrophic from severe uveitis. The publication of this work preceded that of my researches [10] by several weeks (the results of my work were published in March 1935). Other reports on the same subject have since been published by von Szily in the *Klinische Monatsblätter für Augenheilkunde* in 1935 and 1936.

Because of the occurrence of a certain number of cases of bacterial contamination in the direct inoculation of trachomatous material I conceived the idea of avoiding this danger by treating the material used for inoculation with glycerin; this would also test the resistance of the agent of trachoma to glycerin.

In May 1935 I communicated to the Société de biologie [11] that I had observed, after the intravitreous inoculation of glycerinated tra-

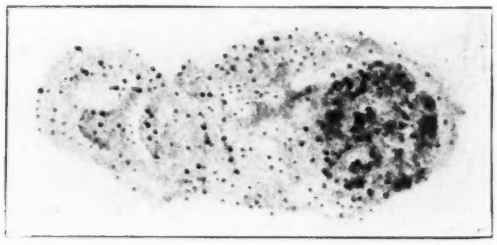

Fig. 6.—Large mononuclear cell of a trachomatous follicle with rickettsias in the protoplasm; smear stained with victoria blue; × 1,410.

chomatous material into the eyes of the rabbit and the chicken, the appearance of intra-ocular nodules; nevertheless the questions which arose as to the interpretation of my previous experiments have led me to speak of the presence in trachomatous tissue of a virus resistant to glycerin and not of the resistance of the trachoma virus to this alcohol.

Suspecting, from retrospective examination of my results, that the factor "quanitity of injected material" could play a rôle in the production of these nodules, I proceeded with tests on controls. I saw intra-

9. von Szily, A.: Uebertragungsversuche mit Trachommaterial; Ein weiterer Beitrag zur Kenntnis follikelbildender Erreger, Klin. Monatsbl. f. Augenh. **94**: 1 (Jan.) 1935.

10. Busacca, A.: Nouveaux résultats en pathologie expérimentale du trachome, Compt. rend. Soc. de biol. **120**:167, 1935.

11. Busacca, A.: Sur la présence dans les tissus trachomateux d'un virus résistant à la glycérine et transmissible en série aux animaux, Folia clin. et biol. **7**:63, 1935.

ocular nodules appear after the intravitreous inoculation of a very heavy glycerinated emulsion of normal intra-ocular membranes. Basing my opinion on the fact that one obtains intra-ocular nodules by the intravitreous inoculation of different materials (von Szily noted such nodules after the inoculation of material from eyes enucleated for sympathetic ophthalmia and after the inoculation of trachomatous conjunctivae, and I noted similar nodules after the inoculation of fragments of cornea affected with trachomatous pannus, of trachomatous conjunctiva conserved from eight to fifteen days in glycerin or of normal glycerinated material), I have come to the conclusion that the nodular reaction of intra-ocular tissues ought to be considered as a reaction peculiar to this tissue and not as a reaction to a category of germs.[12] Probably one should attribute to these nodules the same significance as to those (lymphatic follicles) observed in certain experimental conditions by other authors (Greggio[13] observed lymphatic follicles in the interstitial tissue of the kidney of the rabbit after staphylococcic infection; Lang[14] noted such follicles in the mesentery of rabbits treated with phenylhydrazine or sapotoxin, and other investigators have made similar observations). They are, moreover, of the same type as those described by Zimmermann[15] and others in atrophic eyes and by Woods and Chesney[16] in eyes inoculated with material from the eyes of horses with moon blindness.

In regard to the demonstration of rickettsia-like bodies in the experimental material, my researches have not, up to now, given very satisfactory results. As I have stated, such bodies were demonstrated with relative ease in the cells of the vaginal sheath of the testicles of inoculated guinea-pigs. On the other hand, I never have observed them in the endothelium of the cornea after the inoculation of trachomatous material into the anterior chamber, in smears from various intra-ocular tissues after intravitreous inoculation or even in eyes in which nodules had developed. Finally, in one single case of a fowl in which an imposing nodular conjunctivitis developed after the inoculation of

12. Busacca, A.: Sur la valeur des nodules qu'on obtient après inoculation intravitréenne de matériel trachomateux, Folia clin. et biol. **7**:180, 1935.

13. Greggio, L., cited by Maximow: Bindegewebe und blutbildende Gewebe, in von Möllendorf, W.: Handbuch der mikroskopischen Anatomie, Berlin, Julius Springer, 1928, vol. 2, p. 373.

14. Lang, cited by Maximow: Bindegewebe und blutbildende Gewebe, in von Möllendorf, W.: Handbuch der mikroskopischen Anàtomie, Berlin, Julius Springer, 1928, vol. 2, p. 373.

15. Zimmermann, S.: Ueber Rundzellenherde in der Uvea atrophischer Augen, Ztschr. f. Augenh. **57**:279, 1925.

16. Woods, A. C., and Chesney, A. M.: The Transmission of Periodic Ophthalmia of Horses by Means of a Filterable Agent, J. Exper. Med. **52**:637, 1930.

glycerinated trachomatous material I was able to demonstrate some rickettsia-like bodies in smears made from fragments of the nictitating membrane.

CONCLUSIONS

Such are the facts observed in the course of these last years by me and by other authors in the domains of the etiology and experimental pathology of trachoma. From these facts some new ideas have been introduced into the study of this chapter of ocular pathology which is still surrounded by mystery. The researches are too recent and too few as yet to permit the drawing of definite conclusions. It is better to wait until further investigations clarify the questions relative to this interesting problem.

METASTATIC PNEUMOCOCCIC UVEOSCLERITIS FOLLOWING PNEUMONIA

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Metastatic infections of the inner ocular structures are not rare. The septic embolus is usually carried into the eye either through the retinal or through the uveal system of blood vessels. Experiments of Selenkowsky and Woizechowsky [1] demonstrated that the embolus usually lodges in the posterior segment of the eye, i. e., in the retina (if carried by the central retinal artery) or in the choroid (if carried by one of the short posterior ciliary arteries).

Infections of the anterior segment of the eye, i. e., of the iris and ciliary body, are usually supposed to be transmitted by the long posterior ciliary arteries. These arteries enter the interior of the eye near the posterior pole and run, one on the nasal side, the other, on the temporal side, of the eyeball, between the choroid and the sclera, as far as the ciliary muscle. At the root of the iris each divides into two branches which run in a direction concentric to the limbus and form the major arterial circle of the iris. The common type of infection transmitted through this path is an inflammation of the iris and ciliary body designated by Friedenwald [2] as subacute iridocylitis, in contradistinction to acute purulent iritis or cyclitis, which is characterized by formation of a localized abscess. The latter type of inflammation is usually accompanied by a hypopyon or even by a corneal ring abscess which may result in perforation of the cornea.

The anatomy of the uveal system of blood vessels suggests a possibility of one or more types of metastatic infection of the anterior ocular segment, namely, transmission of the embolus through one of the anterior ciliary arteries. These arteries, usually seven in number, are branches of the muscular arteries and pierce the sclera between the attachments of the muscular tendons and the limbus. They supply the ciliary body and communicate with the major arterial circle of the iris.

In the case which is reported in this paper the patient showed a violent inflammation of the sclera and of the uvea, simultaneously with formation of an abscess between the limbus and the tendon of the

1. Selenkowsky, J., and Woizechowsky, N.: Experimental Work on Metastatic Panophthalmitis, Arch. f. Augenh. **47**:299, 1903.

2. Friedenwald, Jonas S.: The Pathology of the Eye, New York, The Macmillan Company, 1929, p. 44.

superior rectus muscle. Such a location of an abscess could be explained by lodging of a septic embolus in one of the scleral canals formed by the anterior ciliary arteries.

Intra-ocular endogenous infections are often caused by pneumococcus. In the monograph of Seguini [3] 24 cases of ocular metastatic infection due to pneumococcus are reported and contrasted with 29 cases of ocular metastatic infection of other bacterial origin. The same monograph, however, contains in addition a description of 250 cases of endophthalmitis of undetermined bacteriologic origin.

The first description of pneumococcic metastatic endophthalmitis was published by Axenfeld [4] in 1894. In one of his cases the condition was traced to hematogenous infection, and in the other, in which the disease followed pneumococcic meningitis, the patient showed bacterial infiltration along the arachnoid spaces into the optic nerve and into the eyeball. Complete clinical and pathologic descriptions of pneumococcic endophthalmitis were published by Bussola,[5] Lawson [6] and Heinomen.[7] In the case reported by Bussola the condition was bilateral. The left eye became affected on the seventh day of pneumonia. The ocular symptoms started with iritis in the left eye, which was rapidly followed by a ring abscess of the cornea and resulted in perforation of the cornea six days later. The right eye presented symptoms of endophthalmitis four days later than the left eye, and a ring abscess developed twenty-four hours before death from meningeal complication. In the case reported by Lawson the condition followed pneumococcic otitis media. It was also characterized by a ring abscess and perforation of the cornea. In the case reported by Heinomen the condition followed an attack of common cold, and the ocular embolus appeared with the beginning of menstruation. The eye had to be eviscerated.

In none of the reports just cited did the location of the abscess correspond with that in my case.

Descriptions of metastatic scleritis do not tally any better. Nodular scleritis is usually ascribed to focal infection, without determination of the bacteriologic features, to tuberculosis or to syphilis. This disease

3. Seguini, A.: Coroidite metastatica, Ann. di ottal. e clin. ocul. **7**:301 (April) 1923.

4. Axenfeld, T.: Ein weiterer Beitrag zur Lehre von der eitrigen metastatischen Ophthalmie, Arch. f. Ophth. **40**:4, 1894.

5. Bussola, E.: Bilateral Pneumococcic Infection of the Eye in Pneumonia, Boll. d'ocul. **10**:987 (Sept.) 1931.

6. Lawson, L. J.: Metastatic Panophthalmitis Following Pneumococcic Otitis Media, J. A. M. A. **101**:599 (Aug. 19) 1933.

7. Heinomen, Oskar: Case of So-Called Spontaneous Panophthalmia, Finska läk.-sällsk. handl. **74**:360 (April) 1932.

has a more protracted course and less fulminant symptoms. So-called malignant scleritis of von Hippel, which is accompanied by intra-ocular complications, is of tuberculous origin. Robert Hesse [8] examined one patient microscopically and found that the intra-ocular involvement was localized mainly in the choroid and only in a lesser degree in the ciliary body. In my case the main intra-ocular involvement was in the ciliary body. Besides that, the condition in my case was definitely of pneumococcic origin, while in the case of Hesse it proved to be tuberculous.

According to Selenkowsky and Woizechowsky,[1] the actual occurrence of intra-ocular metastatic infection depends on the degree of bacteremia and on the presence of trauma to the eyeball. This contention is supported by the deduction of Seguini [3] that toxic lesion of the arteries is necessary for the development of an ocular metastasis. Heinomen [7] ascribed the ocular metastasis of his patient to premenstrual constriction of capillaries as described by Hagen.[9] None of these etiologic factors was present in my patient. The ocular symptoms started in the intermenstrual period. There was no history of trauma to the affected eye. The healthy eye was under constant observation, and no vascular changes could be seen in the retina, choroid or ciliary vessel. It can be assumed that vascular or retinal changes would be noticeable also in the healthy eye if such changes were contributory to the development of the metastasis in the affected eye.

It was probably an anatomic factor which determined the localization of the embolus, namely, narrowing of the artery and rigidity of the tissues surrounding the anterior ciliary artery as it passes through the sclera.

REPORT OF A CASE

History.—M. W., a white woman, a widow, aged 40 years, was admitted to the St. John's Long Island City Hospital, Long Island City, N. Y., on May 25, 1935, for lobar pneumonia of the right lung. The previous history and the family history were irrelevant. A blood culture taken on June 6 showed pneumococci which did not react with specific antiserums types I, II, III, V, VII and VIII. The disease had the usual febrile course and ended on June 10 with resolution. On June 12 the left eye appeared red and was very painful, and the patient's sleep was disturbed. On June 14 I was called for consultation regarding the ocular condition.

Examination of the Eyes.—This was carried out on June 14.

Right Eye: Vision was 20/20. External examination gave negative results. The cornea was clear. The iris was blue, and the pupil was narrow and regular and showed a prompt light reflex. The media were clear. The fundus was without pathologic changes. The tension was 17 (Schiötz).

8. Hesse, R.: Zur pathologischen Anatomie der Skleritis, Ztschr. f. Augenh. **83**:324 (July) 1934.

9. Hagen, W.: Tuberkulose und Kapillarsystem, München. med. Wchnschr. **70**:532 (April) 1923.

Left Eye: Vision was perception of light; projection was good. Both lids were swollen, and the conjunctiva of the bulbus was swollen and diffusely red. The swelling extended into the lower fornix. The circumcorneal vessels were injected and purplish. The cornea was steamy. The anterior chamber was deep. The pupil was about 2 mm. in diameter, irregular and filled with light grayish exudate. Posterior synechiae were present around the whole pupillary margin. Iris bombé was present; the iris was greenish. A corneal microscope was not available, but on examination with the corneal loupe Descemet's membrane did not show any deposits. The fundus reflex could not be obtained. The tension was 35 (Schiötz). Practically equal luminosity of both pupils was obtained by transillumination from all directions.

There was an extremely hypersensitive area in the sclera located between 12 and 3 o'clock in the ciliary zone. The patient localized the pain in this segment even without touching the eyeball. However, no increased infiltration or congestion could be observed in the painful area, compared with other parts of the sclera.

The lacrimal sac and puncta were normal.

There was no evidence or history of trauma.

Binocular excursions of the muscles in six cardinal directions were not impaired and caused no pain.

General Physical Examination.—The results of the physical examination had been recorded on the previous day by Dr. E. W. McLave. Examination had revealed a few moist râles in the region of the right hilus. The ears and nose showed no pathologic changes. The pulse rate was 90 in the afternoon. The temperature was 99.8 F. The action of the heart was regular, and the sounds were clear. The blood pressure was 125 systolic and 80 diastolic.

Treatment.—This consisted of instillations of a 4 per cent solution of atropine sulfate and hot applications over the left eye, sodium salicylate in solution, in doses of 1 Gm., three times a day, and intramuscular injections of sterile milk protein.

Operations and Course.—Atropine failed to disrupt the synechiae and to dilate the pupil. The iris bombé was not reduced. Swelling of the conjunctiva gradually increased, and on June 16 the swollen conjunctival and episcleral tissues started to protrude between the eyelids. The cornea remained hazy and the tension continued to be around from 35 to 40 (Schiötz). The pupillary exudate did not increase. Pain was very severe. Perception of light was not lost, and luminosity on transillumination was not noticeably decreased.

On June 18 paracentesis of the anterior chamber was performed with the patient under local anesthesia. Retrobulbar injection of a 2 per cent solution of procaine hydrochloride was carried out. The chamber was entered with a cataract knife through the swollen conjunctiva and through the limbus from the temporal side, a little above the equator of the cornea. The bowed iris was transfixed in four places, and the point of the knife was allowed to emerge through the limbus under the swollen conjunctiva of the nasal side. During the withdrawal of the knife a piece of iris prolapsed between the lips of the sclerocorneal incision on the temporal side. No attempt was made to replace the prolapsed portion because it was well covered by the swollen conjunctiva. The operation was followed by immediate relief of pain.

On June 19 the cornea was clear; the anterior chamber had reformed and contained clear aqueous, and a small amount of viscous exudate was present in the pupil. The iris was flat. Edema of the conjunctiva increased enormously. The

swollen lower fornix protruded and covered the lower eyelid down to the palpebromalar fold. Measurement of tension with the tonometer was no more possible because the corneal area which remained uncovered by the periconjunctival swelling was too small to admit the contact disk of the instrument. Palpation through the upper eyelid indicated about normal tension. The patient felt comfortable and had no pain.

On June 20 the upper conjunctival cul-de-sac started to protrude. The prolapsed portion had a mushroom-like formation and covered the upper tarsus from the outside. After retraction of the prolapsed parts the visible segment of the cornea appeared clear; the anterior chamber was deep, with the same amount of central exudate as on the day before.

The prolapsed parts were covered with a bandage to which petrolatum had been applied and were irrigated several times a day with hot saline solution.

The condition continued unchanged until June 27, when the upper part of the prolapsed portion began to recede. The patient was fairly comfortable all the time and did not suffer pain.

On June 30 the cornea was again visible. The exudate in the pupil was flat and began to organize. The tension was 15 (Schiötz). The lower fornix was still prolapsed and covered the lower eyelid. Perception of light was present, and projection was good.

Between July 1 and July 8 the mushroom-like protrusion of the upper fornix disappeared, and the upper eyelid again covered the eye. The lower fornix remained prolapsed.

On July 9 a nodular infiltration was observed in the sclera above the upper pole of the cornea. The depth of the anterior chamber began to diminish, and the aqueous became cloudy.

The infiltration was rapidly enlarging and on July 12 was about 1 cm. in diameter, soft, fluctuating and yellow. It was incised with the patient under local anesthesia, and about 0.5 cc. of yellow pus was evacuated. The bottom of the abscess was probed. It appeared soft and raggy and did not have the usual consistency of sclera. No fistula leading into the eyeball was discovered. Culture of the pus revealed pneumococci identical with those obtained from the previous blood culture.

After the evacuation of the pus the eyeball was very soft, and the remaining edema of the conjunctiva rapidly diminished.

On July 15 the patient was discharged from the hospital. On the day of discharge perception of light was still preserved; projection into the nasal field was doubtful. The anterior chamber was shallow, and the eye was very soft.

Through the whole course of this ocular complication the temperature alternated daily between 98.5 and 100.5 F.; it returned to normal after evacuation of the pus. No other purulent foci were observed in other organs. The right eye did not show any symptoms of inflammation or irritation.

After discharge from the hospital the patient was observed in the office. Within about four weeks the affected eyeball had shrunk, and perception of light was lost. The eye was finally enucleated on March 16, 1936, with the patient under general anesthesia. The site of the abscess was marked by insertion of a black silk suture into the sclera, and the eyeball was sectioned by Dr. Joseph Levine in the Manhattan Eye, Ear and Throat Hospital. The microscopic examination was made by Dr. Levine. The report, which was made on April 27, is as follows:

Microscopic Examination.—The specimen was received in March 1936.

The globe was shrunken and deformed. The cornea was irregularly wrinkled, and the layers of epithelial cells were irregular in thickness. Some of the basal cells were vesicular.

There were many blood vessels throughout the cornea. The lenticular space was filled with a homogeneous granular fluid; the cells of the anterior capsule had proliferated.

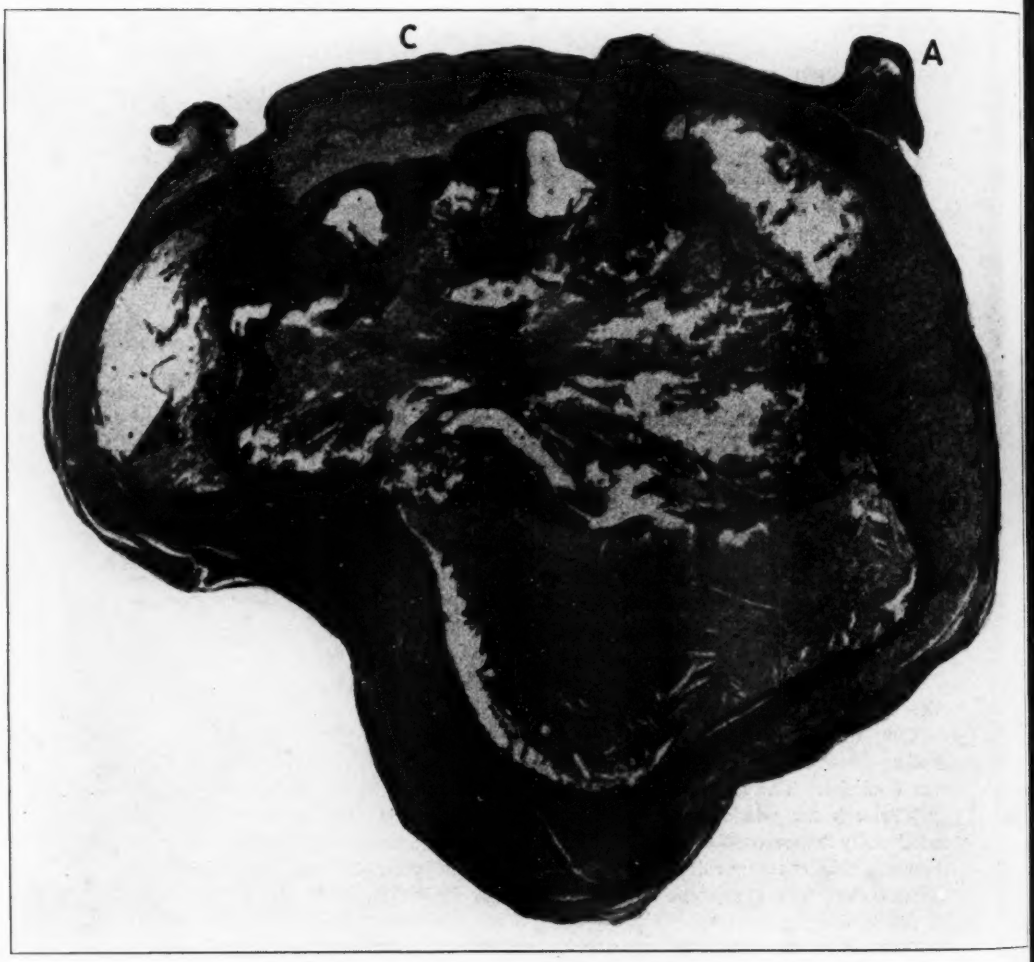


Fig. 1.—Section showing metastatic pneumococcic uveoscleritis resulting in phthisis of the eye. *A* shows the black silk suture inserted above the healed scleral abscess. *B* is the area shown enlarged in figure 2. *C* indicates the cornea, and *D*, the ciliary body.

The iris was enormously thickened by an infiltration with inflammatory cells, and the pigment epithelium had proliferated.

Descemet's membrane was markedly thickened and was folded on itself in many places. The anterior chamber contained an albuminous exudate. The ciliary body and processes were distorted and also contained many inflammatory elements. In the region of the ora serrata the remains of the completely detached retina were folded over, and there were many pus cells.

The choroid was wrinkled, as in cases of long-standing detachment of the retina. The space between the choroid and the detached retina was occupied by a

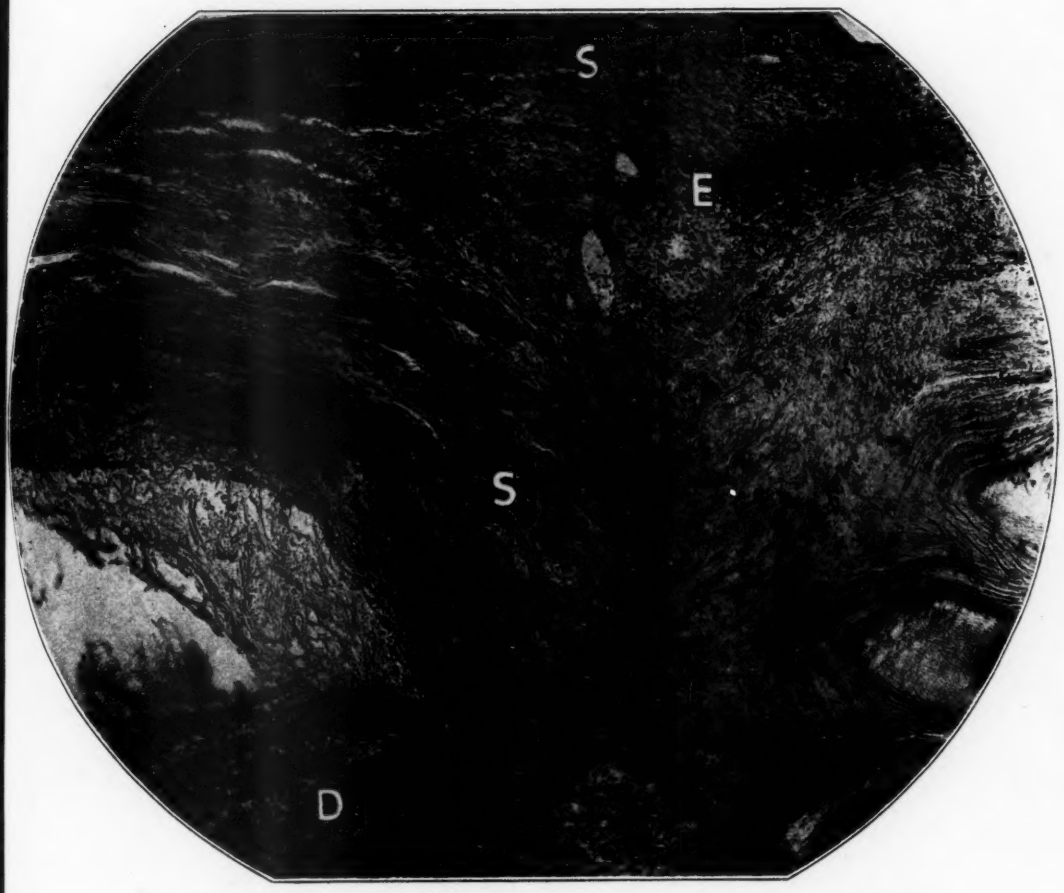


Fig. 2.—Photomicrograph of section showing the scar in the sclera connecting the infiltrated ciliary body, *D*, with the episcleral tissue, *E*. *S* indicates the sclera, which is wrinkled in the upper part of the section.

homogeneous albuminous exudate, somewhat similar to that seen in the anterior chamber. There was no doubt that infection was localized in the anterior segment of the eye, that is, the ciliary body and iris.

Pathologic Diagnosis.—The diagnosis made on the basis of the pathologic examination was phthisis bulbi following endophthalmitis.

COMMENT

The condition in this case can be classified neither as simple metastic endophthalmitis nor as simple metastatic scleritis, for the following reasons:

1. From the onset of the ocular complication the tenderness was localized in the ciliary region above the upper pole of the cornea, without signs of localized scleral infiltration.

2. The symptoms of intra-ocular inflammation were comparatively mild, as manifested by good projection and perception of light and by normal transillumination until phthisis set in.

3. Primary involvement of the uveal tract was manifested by the rapid formation of pupillary occlusion at the very onset of the disease.

4. The enormous swelling of the conjunctiva and of the episcleral tissue points to simultaneous scleral involvement.

5. There was only a small amount of pus evacuated from the abscess, which did not communicate with the vitreous chamber.

6. Section of the eye showed organization in the anterior half of the eyeball, the posterior half having remained relatively intact (fig. 1).

7. Infiltration of the sclera is still visible on the section. It formed a path leading from the ciliary body through the sclera into the episcleral tissue (fig. 2).

It can be assumed that a septic embolus lodged in one of the anterior ciliary vessels as it transfixes the sclera on its course from the muscular artery to the ciliary body.

Therefore this case should be classified as one of metastatic uveoscleritis following pneumonia.

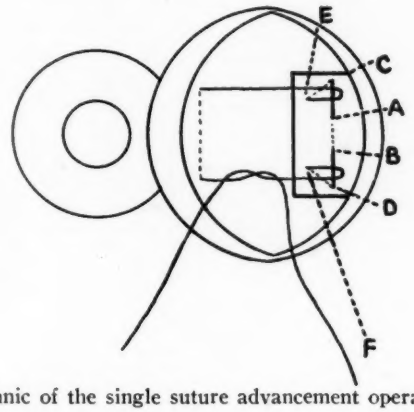
Clinical Notes

A SINGLE SUTURE ADVANCEMENT OPERATION

GUY A. HUNT, M.D., BUTLER, PA.

This operation is submitted as my modification of Prince's advancement operation, particularly regarding the insertion of the suture in the tendon of the muscle.

A vertical incision is made in the conjunctiva about 6 mm. from the limbus. After the conjunctiva is undermined up to the limbus and over the tendon of the muscle, Tenon's capsule is buttonholed at one side of the tendon, a strabismus hook is inserted under the tendon, and Tenon's capsule is incised on each side but not stripped from over the tendon. A Prince's advancement forceps is now applied near the insertion of the tendon, with the handle of the forceps toward the cornea, and the tendon is cut close at its insertion.



Technic of the single suture advancement operation.

I use a double-armed suture of 000 ten day chromacized catgut and substitute for one of the atraumatic needles (which come with the suture) a Jameson needle to be used in picking up the scleral fibers.

The needles are first entered at *A* and *B* from the scleral surface of the tendon so as to include the middle quarter of its width between these two points. One needle is now passed inward through the tendon 1 mm. or less from the upper border at *C* and entered again from the scleral surface at *E*, 2 or 3 mm. from the loop *AC* and equidistant from the points *A* and *C*. The same needle is next passed under and then over the loop *AC*, which should then be drawn close to the tendon by traction on the suture near *E*. The other needle is used in a like manner to place the suture in the lower portion of the tendon. After the loops are drawn up closely the ends of the suture are held by an assistant, and the tendon is resected between the forceps and the suture.

In the next step the conjunctiva near the limbus is retracted, and one of the needles is passed under the superficial fibers of the sclera about 1 mm. from the limbus in a vertical direction and with divided bights for a distance of 6 or 8 mm. The suture is then carefully drawn up so as to approximate the end of the tendon with the sclera near the limbus and tied. The conjunctiva is sutured with silk or plain catgut.

The three advantages claimed for this operation are: (1) assurance that the suture will not pull out of the tendon, since the loops tighten with an increase in traction; (2) a strong scleral attachment; (3) proper alinement of the muscle.

The argument that single suture advancement operations cause pointed or contracted attachments does not hold true for the operation just described, since the sides of the tendon do not curl under and the end is held in firm contact with the sclera to the extent of the width of the tendon. The correctness of this may be demonstrated by inserting the suture in a piece of tape ⅜ inch (9.6 mm.) wide. Also, with the same tape it may be shown that if the points of insertion are near the borders in following Prince's method the sides of the tape will curl under so as to contract the width of the end; but by making the loop to include the middle fourth such curling does not occur. In the operation described I have therefore included only the middle fourth of the tendon in the central loop.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

GENERAL ANESTHESIA IN OPERATIONS ON THE EYE, EAR, NOSE AND THROAT

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ROCHESTER, MINN.

The administration of general anesthetics by inhalation for operations on the eye, ear, nose and throat has been rather well standardized in the past. The commonest method has been the induction of anesthesia by nitrous oxide or ethyl chloride and its maintenance by ether administered by the drop method followed by insufflation of ether vapor from the Junker bottle or from some mechanical insufflator if the operation is that of tonsillectomy or some other procedure on the throat. When a gas machine was available, a gas, such as ethylene, with or without ether, has been used extensively, but since this article is purposely limited to those recent advances which have allowed the surgeon an increasing choice in the methods of operations the older methods of inducing anesthesia are referred to only briefly.

The use of a Magill large bore soft rubber intratracheal tube has made the administration of anesthetics by inhalation easy and has removed the anesthetist and devices from the field of operation, so that the surgeon may operate without interference from difficulties arising from the administration of the anesthetic or the moving of the face mask. Surgical asepsis has been more easily maintained and the exposure of the operative field has been maximal with this method. When the operation is to be on the throat the tube may be passed by way of the nose (fig. 1), and when the operation is to be on the nose the tube may be passed by way of the mouth (fig. 2). In operations on the eye the tube may be introduced by either route. The intratracheal method is seldom necessary for a person who is to have an operation on the ear, although it is used to advantage in such an operation if there is any difficulty in establishing a free passage of air.

For the average patient, as preliminary medication 1½ grain (0.09 Gm.) of pentobarbital sodium is administered by mouth the night

From the Section on Anesthesia, the Mayo Clinic.

This is a review article based on a lecture given at the meeting of the American Academy of Ophthalmology and Otolaryngology in New York on Sept. 29 and 30 and Oct. 1, 1936.

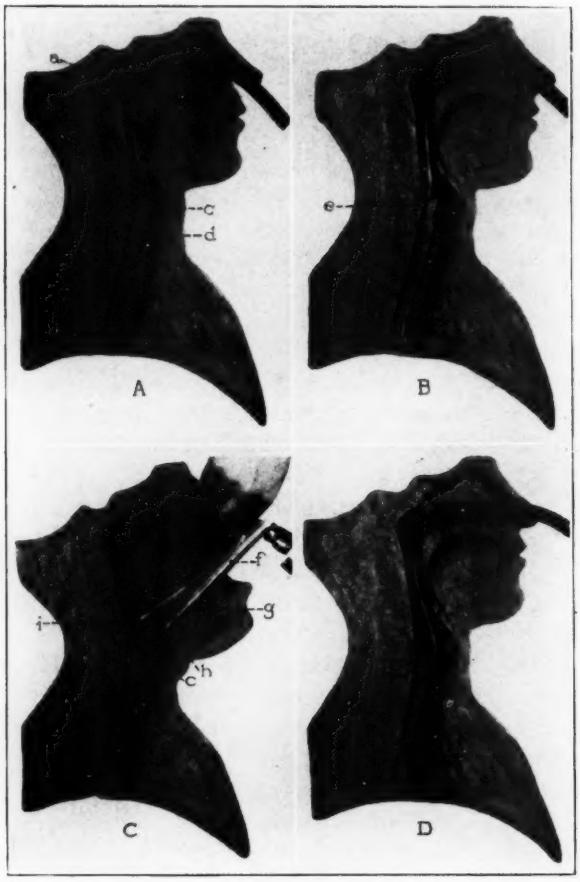

Fig. 1.—*A* shows the intratracheal tube inserted through the nose, passing through the nasopharynx (*a*) and extending deeply into the oropharynx (*b*), toward the larynx (*c*) and the trachea (*d*). *B* illustrates how in many cases the intratracheal tube enters the esophagus (*e*) instead of the trachea on the first attempt to insert it. If it continues to enter the esophagus with each of several attempts, the laryngoscope should be used. In *C* the laryngoscope (*f*) is inserted to depress the tongue (*g*) and the epiglottis (*h*), and the glottis (*c*) is visualized. The intratracheal tube may then be inserted through the glottis into the trachea by grasping the tip of it with the Magill forceps (*i*) and directing its course. Often, however, after the glottis is visualized the tube may be inserted by manual pressure on the tube from outside the nose. *D* shows the intratracheal tube in the proper position when it has been inserted through the nose.

before the operation.[1] The dose is repeated at 7 a. m. In the case of an average adult, 1/6 grain (0.01 Gm.) of morphine sulfate and 1/150 grain (0.0004 Gm.) of atropine sulfate are given by hypodermic injection at least thirty minutes before anesthetization is to be begun.

The essential points in using this intratracheal method are to spray the throat with a local anesthetic, such as a 5 or 10 per cent solution of butyn, and to induce anesthesia with a gas such as nitrous oxide, ethylene or cyclopropane.

A tube with an outside diameter such as will permit it comfortably to enter the nose, glottis and trachea is selected and lubricated with white petrolatum (figs. 3 and 4). When anesthesia has been established, the tube is inserted through the nose so that it follows the flow

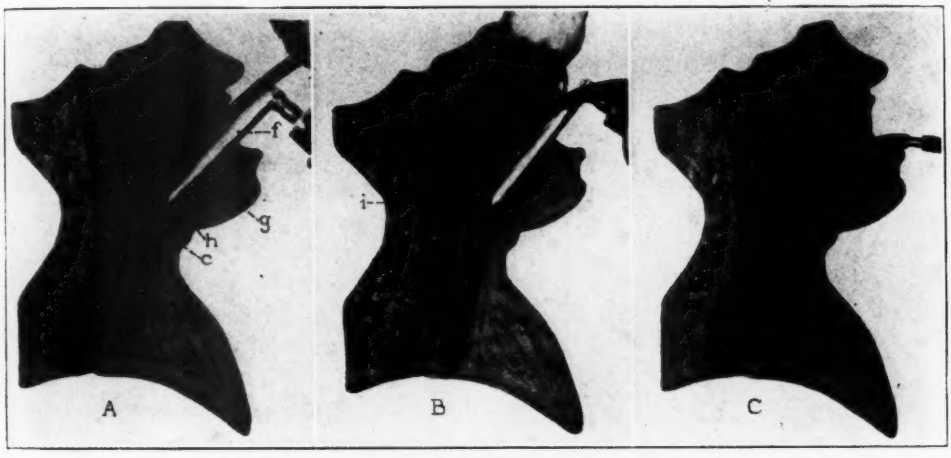

Fig. 2.—*A* shows oral intubation; *B*, oral intubation with a forceps, and *C*, the tube in place.

of air. A hollow blowing sound may then be heard, which assists materially in guiding the tube into the glottis. If the tube does not enter the glottis readily, the laryngoscope is used; the tongue and epiglottis are lifted, and the larynx is exposed. The tube may then be inserted from the outside by the use of Magill's forceps, the tip being guided between the tube and the vocal cords. In a rare case a divided airway may be used. It is inserted through the mouth, with the point against the glottis, and the intratracheal tube is inserted directly. The airway is removed a half at a time or may be allowed to remain in place.

1. Lundy, J. S.: Rôle of Preliminary Medication in Anesthesia, Surg., Gynec. & Obst. **63**:117-119 (July) 1936.

The advantages of the use of the tube are the effortless breathing of the patient and the easy administration by means of the gas machine of whatever mixture of anesthetics one wishes to use, including the administration of volatile agents by any device which will permit the

Fig. 3.—Four sizes of intratracheal tubes. The sizes from top to bottom are: (1) 8 mm. in diameter and 180 mm. in length; (2) 10 mm. in diameter and 215 mm. in length; (3) 11 mm. in diameter and 270 mm. in length, and (4) 14 mm. in diameter and 280 mm. in length.

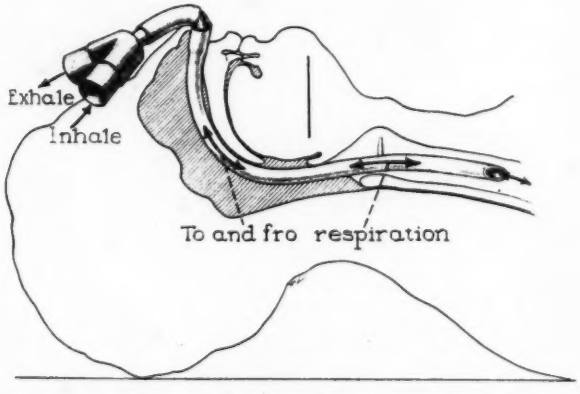

Fig. 4.—To avoid collapse of the tube, a metal connecter is used when the tube otherwise would be forced into an acute angle, and the connecter and adapter on the end of the inhaler tubing are joined by a short piece of rubber tubing. The direction of the inhaler tubing from the patient to the gas machine may be arranged at any angle convenient for the surgeon and the anesthetist by rotating the metal connecter in that direction.

vapors to be inhaled or insufflated through the tube. Obviously, artificial respiration is an easy matter with the tube in place. The advantages are so apparent that it seems to me that one needs only to use

the method once or twice to realize them. This method is, I think, one of the outstanding advances in the means of inducing general anesthesia in the last ten years. One does not necessarily need a gas machine or mechanical devices to enjoy many of the benefits of the method. The tube may be inserted and left protruding slightly and fastened in place with adhesive tape. Then ether may be administered by the drop method so long as the end of the tube is kept under the mask.

Among the various agents used, some new ones have recently been employed. One is divinyl ether, which I have found less satisfactory than diethyl ether, although in the recent literature it has been discussed as being possibly and probably advantageous for use for myringotomy and for short operations when anesthesia is to be induced quickly and maintained for a short time. Because breathing has not been quiet and effortless with this agent, I have limited its use in my hands. Nitrous oxide is an extremely valuable agent, as it may be used with relative safety in cases in which cautery and diathermy are necessary. Ethylene has not been as popular, mostly because of its inflammability, although more oxygen can be given with it than with nitrous oxide. Cyclopropane, which was developed by Waters,[2] can be used with equal success in operations on the ear, but it too is inflammable and explosive, so that its use is limited in many of the operations on the eye, nose and throat if diathermy or cautery is to be used. It is, however, an excellent anesthetic agent when the conditions of operation permit its use, especially if one wishes to avoid the use of ether. Anesthesia may be induced, the intratracheal tube may be placed, and anesthetization then may be carried on with nitrous oxide and oxygen. However, there is some danger in having an inflammable gas on a gas machine, as the valve on the cylinder may not always be closed tightly and some gas may leak through into the mixture in the bag without the knowledge of the anesthetist or the surgeon until it becomes ignited. So, for the most part, when ethylene and cyclopropane are used, the cylinders should be on the gas machine only for the period during which the gas is used. This precaution may seem unnecessary, but the hazard is real enough to warrant it. The penalty of an explosion is too great if such care is not taken.

When cyclopropane is to be used, a special gas machine that has valves that are unaffected by the gas and one that includes a soda lime absorber for carbon dioxide is necessary. With this method, although the gas is expensive per cylinder it is not expensive per case. Obviously, the expense of nitrous oxide and of ethylene is equally reduced by the

2. Waters, R. M., and Schmidt, E. R.: Cyclopropane Anesthesia, J. A. M. A. **103**:975-983 (Sept. 29) 1934.

carbon dioxide absorption method, which was also developed by Waters.[3] A warning in the use of cyclopropane is that the patient may easily become overdosed with it when anesthesia is too suddenly induced. The character of the pulse should be watched as deep anesthesia is approached, and if the quality of the pulse changes an increasing dose of ether should be added rather than increasing the concentration of gas in the mixture. While death has occurred from the too bold use of cyclopropane, I am satisfied that the lives of many patients have been prolonged by its use when disease of the lung has existed and when without cyclopropane ether must have been used, with subsequent exacerbation of a pulmonary disease.

For certain short operations, such as enucleation of an eye and myringotomy, one may induce and maintain anesthesia by the intravenous use of evipal (sodium n-methylcyclohexenylmethylmalonyl urea)[4]

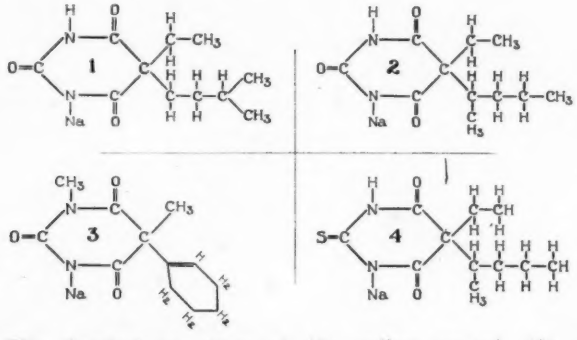

Fig. 5.—The chemical structures of (1) sodium amytal, (2) pentobarbital sodium, (3) evipal sodium and (4) pentothal sodium. Sodium amytal and pentobarbital sodium are similar in chemical structure, and they have a similar effect. Evipal sodium and pentothal sodium, although differing somewhat in chemical structure, have a similar effect. The one difference between the latter two substances and the former two substances is the utilization of bonds on the urea side of the barbituric acid nucleus as well as on the malonic acid side for substituents in the formulas for evipal sodium and pentothal sodium, while in the formulas for sodium amytal and pentobarbital sodium the bonds on the malonic acid side only have been utilized.

or of pentothal sodium (sodium ethyl l-methyl butyl thiobarbituric acid).[5] Since evipal has been sufficiently described in medical litera-

3. Waters, R. M.: Clinical Scope and Utility of Carbon Dioxide Filtration in Inhalation Anesthesia, Anesth. & Analg. **3**:20-22 (Feb.) 1924.

4. Evipal has not been accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

5. Lundy, J. S.: Intravenous Anesthesia: Preliminary Report of the Use of the Two New Barbiturates, Proc. Staff Meet., Mayo Clin. **10**:536-543 (Aug. 21) 1935. Pentothal sodium has not been accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

ture in this country and abroad, my remarks will concern pentothal sodium. Its relation to amytal (iso-amylethylmalonyl urea) and evipal is illustrated in figure 5. Pentothal sodium is from 30 to 50 per cent more potent than evipal. It is to be used only in a 5 per cent concentration. A respiratory stimulant may be mixed in the solution; 1 cc. of pyridine betacarbonic acid diethylamine, 3 mg. of picrotoxin,[6] or 3 grains (0.2 Gm.) of metrazol is added to 1 Gm. of pentothal sodium. The drug is given intermittently, as indicated in figure 6. Whenever possible, a "cotton butterfly" [7] is used over the nostrils or lips of the patient to indicate the inspiration or expiration of air, and the respirations should at no time be entirely inhibited by the drug.

The preliminary medication is the same as that used with other anesthetics.

The patient is asked to count, and it is best to induce anesthesia slowly enough so that the patient counts to between 20 and 30. Anesthesia may be easily induced in ten seconds, but there is a danger which is out of proportion to that of induction in from twenty to thirty seconds. I feel that the responsible person who uses this drug should never allow respiration to be stopped. Anesthesia should be induced slowly, and small doses should be given intermittently, when and if they are needed, the principle of the intermittent method of administering ether by the drop method being followed. The use of this method is on the increase, and the procedure is one that needs to be mastered by those who are interested in it. It is not a method that should be used by those who are inexperienced or who are not cautious. It is not recommended in cases in which the patient is a child less than 10 years of age because of the small caliber of the respiratory passages, which, together with the depression of respiratory action by the drug, makes pulmonary ventilation by the patient difficult. Cyanosis of the patient should be avoided, and if it occurs it should be treated promptly, as the outcome may easily be untoward if the cyanosis persists.

The use of pentothal sodium should be avoided in cases in which the patient suffers from respiratory disease, one of the symptoms of which is dyspnea when the patient is at rest. Its use for manipulations in the throat is usually not satisfactory unless the throat has been anesthetized by a local anesthetic before general anesthesia has been induced for bronchoscopy and other such procedures. If the intravenous anesthetic is to be used for tonsillectomy, the intratracheal tube should be inserted so that there will be a free airway throughout the operation and

6. Picrotoxin has not been accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

7. Lundy, J. S.: A Method of Minimizing Respiratory Depression When Using Soluble Barbiturates Intravenously, Proc. Staff Meet., Mayo Clin. **10**:791-792 (Dec. 11) 1935.

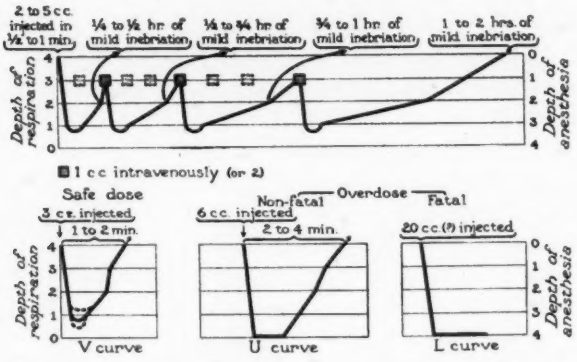

Fig. 6.—Diagrams showing the effect of the doses of pentothal sodium given by intravenous injection for a man aged 45, weighing 160 pounds (72.6 Kg.) and 6 feet (182.9 cm.) tall. The preliminary medication consisted of the administration of ⅙ grain (0.01 Gm.) of morphine and 1/150 grain (0.0004 Gm.) of atropine given by hypodermic injection and the oral administration of 1.5 grain (0.09 Gm.) of pentobarbital sodium. The effect produced by the administration of a 5 per cent solution of pentothal sodium by different technics is shown. To avoid the necessity of drawing two curves in each diagram it is assumed that anesthesia deepens as respiration becomes more shallow and that this relationship is exact. The relationship may not be exact, but for diagrammatic purposes the assumption will serve. The top diagram shows the effect on the depth of respiration and of the anesthesia produced by repeated safe doses. After the first dose, respiration becomes more shallow and anesthesia deeper for a time; then, as the patient begins to recover, respiration deepens and anesthesia becomes lighter until the patient reaches a stage of inebriation which will last for from a quarter of an hour to half an hour. If the operation has been completed in the relatively short period of anesthesia conferred by the first dose, no more of the drug need be administered, and after the stage of inebriation has passed recovery is complete. However, if a longer period of anesthesia is required to permit the operation to proceed, a second dose is administered, and so on, with the effects on respiration, anesthesia and duration of inebriation that are represented in the curve. When similar successive safe doses are administered, the last one often, but not always, has a longer effect than the previous ones. The dose varies according to the patient's resistance to the drug. One person may require 2 cc. of a 5 per cent solution for each cubic centimeter, as indicated in the top curve, at least for the first two or three injections. The diagrams marked V curve, U curve and L curve, which show the vulnerability for a 5 per cent solution of pentothal sodium, illustrate the relative effect of the safe dose and of the overdose. The V curve illustrates the safe dose for the short operation, for example, manipulation of a stiff wrist joint. The U curve illustrates the nonfatal result of a moderate overdose; respiration is practically completely depressed for a short time, and recovery is prompt if no more of the drug is injected. It shows that the period of anesthesia is longer than it is when a small dose is injected, and this period of anesthesia is coincidental with respiratory depression. The effect of an overdose, that is, of a dose large enough to be fatal, is illustrated in the L curve and needs no further explanation. Certain modifications of this technic might be carried out, and the L curve could be broken down into two U curves, the second of which might possibly illustrate a fatal result, based on the results obtained in the top curve or if the condition is complicated by any respiratory obstruction.

so that the danger of aspiration of material from the throat will be minimized.

Certain advantages of the method, such as the portability of the agent, the fire-proof conditions, the quick induction of anesthesia, the short period before recovery, the absence of excitement in most cases and also a minimum of nausea and vomiting, are obvious. There is evidence that this drug, if used by this method, tends to delay the onset of shock—a valuable consideration in certain cases in which the patient is debilitated. It usually lowers the blood pressure in cases of hypertension and may be used to advantage in such cases if it is otherwise indicated. The use of pentothal sodium is described elsewhere, and for the benefit of those who are familiar with evipal it may be stated that its use is similar to that of the latter drug, except that a smaller dose of pentothal sodium must be used.

The rectal method of anesthesia was formerly carried out with olive oil and ether and later with tribromethanol in amylene hydrate (avertin fluid).[8] The use of the latter agent in a dose of from 80 to 90 mg. per kilogram of body weight, so that its effect is only that of basic anesthesia, has been satisfactory. It permits operation under minimal additional amounts of local or inhalation anesthetics. Its use in doses sufficient to produce anesthesia is not to be recommended in most instances.

The rectal use of short-acting barbiturates is in the experimental stage and need not be discussed further as yet.[9]

The use of any anesthetic agent or method should be backed by a sufficiently good reason so that its use can be justified in the event of any untoward result. Carelessness in the selection and application of these methods, especially if the routine use of one or more is attempted, may easily lead to difficulties. For example, in using the intravenous method one should master venipuncture if satisfaction is to be expected. It is necessary to know that a needle should always be selected which one feels will easily enter the vein. If the needle is somewhat large, the bevel should be laid against the skin rather than be turned away from it; then when the proximal wall of the vein has been entered there will be a minimal chance that the needle will perforate the distal wall.

I would recommend that the surgeon review the question of modern anesthesia and see the newer methods demonstrated in competent hands, just as one must observe the technical steps of an operation in order clearly to visualize the procedures.

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8. Avertin has not been accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

9. Gwathmey, J. T.: Rectal Administration of Evipal Soluble: A Safe, Reversible and Controllable Preanesthetic Medication; a Preliminary Report, Am. J. Surg. **32**:411-416 (June) 1936.

News and Notes

UNIVERSITY NEWS

Dr. Francis Heed Adler has been appointed to the chair of ophthalmology at the University of Pennsylvania, as successor to the late Dr. T. B. Holloway.

GENERAL NEWS

The National Eye Service.—A new central clinic of the National Eye Clinic has been established at Castle Street, Torquay, England. At the opening ceremony Mr. A. W. Ormond, consulting ophthalmic surgeon to Guy's Hospital, referred to the inauguration of the National Eye Service by the British Medical Association as a public service designed to provide a thorough examination of the eyes by a competent ophthalmic medical practitioner and any necessary glasses at a cost within the means of those who cannot afford ordinary fees but who deserve the best ophthalmic treatment.

SOCIETY NEWS

Ophthalmological Society of the United Kingdom.—The annual congress of the Ophthalmological Society of the United Kingdom will be held in London on April 29 and 30 and May 1, 1937.

The subject for discussion will be "The Rarer Forms of Keratitis." The following members will open discussions: Mr. F. A. Williamson-Noble (neurologic aspects), Mr. Affleck Greeves and Mr. J. Doggart (clinical aspects), Mr. Harrison Butler (slit-lamp aspects), Mr. Frank Law (ultraviolet light therapy) and Dr. Douglas Webster (roentgen therapy). Other members wishing to take part in the discussion should notify Mr. H. B. Stallard, 35 Harley Street, London, W. 1, before February 28.

Further information regarding the program and the presentation of papers may be secured from Mr. Stallard.

Philadelphia County Medical Society, Eye Section.—The monthly meeting of the Eye Section of the Philadelphia County Medical Society was held on December 3. The following program was presented: teaching conferences, by Drs. Lillie, Cowan and Lehrfeld; presentations of clinical cases from the Wills Hospital, by Dr. W. D. Angle, and a symposium on iridocyclitis and uveitis, in which were discussed "Etiology," by Dr. Leo F. McAndrews, "Diagnosis," by Dr. Leighton F. Appleman, and "Treatment," by Dr. Charles R. Heed.

Obituaries

THOMAS B. HOLLOWAY, M.D.
1872–1936

Thomas Beaver Holloway was born in Danville, Pa., on March 24, 1872. He died at his home in Merion Station, Pa., on Aug. 18, 1936. He was the son of S. William Kerling Holloway and Ruth Ann Holloway. Dr. Holloway was twice married. By his first wife, to whom he was married in 1902, Cordelia Gearhart Woolley of Danville, Pa., he had one son, Thomas B. Holloway Jr. In 1931 he married Florence Jane Laird of Philadelphia, who survives him.

His preliminary education, which was completed in 1888, was received at the Danville Academy. For a period of two years he was associated in business with his father. He then entered Lafayette College, and graduated with the degree of B.S. in 1894. In 1897 his alma mater conferred on him the degree of M.S., and in 1926, that of Sc.D.

On biologic qualifications he was admitted to the second year of the medical school of the University of Pennsylvania and graduated in 1897. After serving an internship for two years at the Philadelphia General Hospital, Dr. Holloway began the general practice of medicine in Philadelphia.

Dr. Holloway's career in ophthalmology began in 1902, when he was appointed assistant surgeon at the eye dispensary of the University Hospital in the medical school of the University of Pennsylvania. He was appointed instructor in ophthalmology in 1905, associate professor in 1923 and professor in 1924, succeeding G. E. de Schweinitz. His talents in the field of ophthalmology were quickly recognized, and his services were sought by a number of important hospitals and teaching institutions in and around Philadelphia. In 1914 he was elected professor of ophthalmology at the Philadelphia Polyclinic, and in 1918 was appointed professor of ophthalmology in the graduate school of medicine of the University of Pennsylvania. He was made vice dean for ophthalmology in the latter institution in 1920.

After entering private practice Dr. Holloway spent seven profitable years as the personal assistant of Dr. G. E. de Schweinitz, both in the de Schweinitz' office and at his clinic in the University Hospital. During this period it was only natural that an intimate professional and personal relationship should have developed between the two men.

Many of Dr. Holloway's earlier papers were, therefore, presented with Dr. de Schweinitz as co-author, and this happy custom was continued for some years. Among the most notable contributions emanating from this joint authorship were "Pulsating Exophthalmos," an essay based on sixty-nine case histories, "The Operative Treatment of

THOMAS B. HOLLOWAY
1872-1936

Papilloedema Dependent upon Increased Intracranial Tension" and "Certain Visual Defects in Hypophysis Disease."

Under his own authorship and, frequently, in association with other colleagues, Dr. Holloway presented before ophthalmologic societies or general medical societies well over one hundred interesting and impor-

tant communications, all of which have been published and preserved for posterity. As an extemporaneous speaker on medical subjects he spoke fluently and with conviction, invariably displaying an unusual knowledge of the current literature on the question under discussion.

The esteem in which Dr. Holloway was held by his associates resulted in his election to membership in numerous ophthalmologic, neurologic, pathologic and general medical societies in this country and abroad, and in many of these he was honored with positions of distinction and responsibility. From 1918 to 1925 he was secretary-treasurer of the American Ophthalmological Society and for a period of ten years edited the society's Transactions; he was president of the society in 1932.

In 1918 he was a member of the House of Delegates of the American Medical Association, and was chairman of the Section on Ophthalmology from 1929 to 1930. Elected to fellowship in the College of Physicians of Philadelphia in 1906, he served as clerk of the Section on Ophthalmology from 1909 to 1913 and became chairman of the section in 1924. He was a member of the John Morgan Society, the American Academy of Ophthalmology and Otolaryngology, the Société française d'ophtalmologie and the Ophthalmological Society of the United Kingdom, as well as numerous other special and general medical organizations.

Dr. Holloway had a large and influential private practice in addition to unusual opportunities for clinical and pathologic research in the general and special hospitals with which he was connected. As a clinician he was painstaking, thorough and skilful and never lost sight of the fact that the eye and its diseases were closely allied to general disease and to diseases of the central nervous system. He was an expert ophthalmoscopist and retained to a remarkable degree a clear mental picture of what he had observed in the fundus. His description of the departures from the normal were accurate, instructive and illuminatin He displayed sound surgical judgment and as an operator did his wo with meticulous care. Never slow to adopt new surgical procedures if they had proved to be meritorious, he usually selected the type of operation which he himself did best, and his results compared favorably with those of larger surgical experience.

As a teacher he admirably succeeded in imparting his knowledge in a clear, convincing manner, emphasizing always the close relationship between ocular disease and constitutional disease and ever striving to impress on the undergraduate the importance of ocular examinations in the diagnosis of central lesions, cardiovascular disease and renal disease. As one colleague expressed it, "He continually sought to make

the students eye conscious, rather than endeavored to make of them eye practitioners"—a difficult undertaking at best but one in which his efforts were appreciated by the student body.

Any student of medical history could well record the achievements of Thomas B. Holloway in his special field of activity, but only his close personal friends can give a proper estimate of the outstanding characteristics of the man. Always an indefatigable worker and a diligent reader of ophthalmic literature, he found little time for relaxation, and the demands of social life had little appeal for him. When, however, he was able temporarily to cast aside the burdens and responsibilities incident to his work and surround himself with a group of congenial friends there was never a more delightful companion or one who entered into the spirit of the occasion with more enthusiasm. He took great delight in playing practical jokes on his intimate friends and had a keen sense of humor and a cheerful, buoyant spirit which ever shed its influence on those around him. He was a kind and indulgent father, a devoted and sympathetic husband and a true friend. No task was too hard, no effort too great, when his help and cooperation were sought by friends or professional associates. While a member of several clubs, he was rarely able, because of his active professional life, to use them except for the entertainment of his friends. After the day's work was done he preferred the quiet of his home, where he could be surrounded by his family and, not infrequently, by his close associates.

I had the privilege of knowing Tom Holloway intimately for a long period and saw him frequently during his active years and throughout his last illness. This friendship, which will ever be a cherished possession, endured until the end. Any appraisal of his life, filled as it was with great professional distinction, high honors and the esteem of his fellowmen, would not be complete without reference to the courage he displayed during times of adversity. He had reverses and at times faced conditions which "try men's souls," but never did they embitter him or alter the tenor of his life. Fully aware for several months that his last illness would terminate fatally, he faced death, "the last enemy to be destroyed," with calmness and a courage which excited the admiration of those who were privileged to be with him in those trying hours. Only eager to be spared long enough to "put his house in order" and to dispose of some of his most cherished possessions, he complacently accepted the inevitable outcome without fear, or resentment and in his last days must have derived consolation from the thought that he had fought a good fight and had kept the faith.

HUNTER H. MCGUIRE.

The friends of Dr. Holloway little thought that the illness which befell him in December 1935 would suddenly cut short his life's work and soon after cause his death.

Dr. Holloway's success was assured through his love of work and the high degree of intelligence which he brought to it. The success of the department of ophthalmology in the Graduate School of Medicine of the University of Pennsylvania was largely due to his enthusiastic efforts. He planned the curriculum on a broad basis and in time shaped it into a course which has made it outstanding. In his teaching in the undergraduate school he endeavored to make the students eye conscious rather than to make of them eye practitioners.

In his death the American Ophthalmological Society has lost one of its most devoted members. It claimed much of his time and thought. He was deeply interested in the future of the younger ophthalmologists about him, and to them his death will be a great loss. He will be greatly missed in the Section on Ophthalmology of the College of Physicians of Philadelphia, where he was regular in his attendance, presented many of his best papers and participated freely in discussions.

He was a diligent reader of ophthalmic literature and had a retentive memory, so that even in his extemporaneous discussions he could quote the literature on a subject with amazing facility.

He disliked publicity, was reserved about his personal affairs and was strong in adversity. Reverses did not embitter him or much alter the tenor of his life. He had a cheerful, buoyant disposition.

Ophthalmology has lost a devoted practitioner; students, an enthusiastic teacher, and his colleagues, a steadfast friend.

Deep sympathy is felt for his widow and his son.

W. ZENTMAYER.

The loss of Tom Holloway will be keenly felt by a large circle of acquaintances, while to his many friends his death leaves a void impossible to fill. Especially will his absence be noted by the several ophthalmologic societies of which he was a most active member. Possessed of a most retentive memory of the literature as well as of the contributions of various authors, he was never at a loss for opinions to confirm his own judgment, which was founded on a thorough knowledge and careful study of his subjects. A good judge of men, he was rather outspoken in criticism, but generous in praise, as the case might be.

He was a man of great uprightness and, once having conceived his duty, could not be swayed from his course. He was slow to make friends, but once his friendship was given it was never retracted. He was kindly, considerate, generous to a fault and invariably a gentleman.

He was a great lover of the outdoors and an ardent angler; nothing delighted him more than to follow the course of a stream where trout or salmon were to be found.

Although he was extremely reticent, there were those who were privileged to know him well; these were aware of his high ideal of service and appreciated that it was based on a deep religious conviction.

So Tom Holloway played the game of life as, in years gone by, he had played the game of baseball, taking defeats and victories in his stride, and on the realization of the near approach of the end of his earthly tenure he set about placing in order his material affairs without the least shadow of doubt in his heart.

LOUIS S. GREENE.

CLARENCE KING, M.D.

1877-1936

The many friends of Clarence King were shocked to hear of his sudden death while he was bathing in Grape Bay, Paget, Bermuda, on August 15. The abrupt ending of this useful life while Dr. King was apparently in perfect health and enjoying full activity, at an age so far in advance of the limit of human life set by the Psalmist and constantly demonstrated by human experience, accentuates the keenness of the regret of ophthalmologists that one so favored by nature should be taken from the eminent position he had earned and adorned.

Dr. King was born in Newport, Ky. He graduated from the Medical College of Ohio in 1901 and served his internship at the Good Samaritan Hospital, Cincinnati. Later he studied ophthalmology in Vienna and Berlin, returning to Cincinnati to practice his specialty.

In 1911 he went to Amritsar, India, where he operated in the clinic of Colonel Henry Smith. During the war he served in the Medical Corps in France and in Coblenz, Germany. After he returned home he was in charge of the eye service of the Cincinnati General Hospital and also of the Children's Hospital. He served as assistant professor of ophthalmology under Prof. Victor Ray on the faculty of the University of Cincinnati College of Medicine, and became professor when Dr. Ray died. These three positions occupied a great deal of his time and thought, and the increasing demands made everywhere today on teachers in medical schools were met by him and satisfied.

He visited Vienna in 1927 and studied especially the effects of the treatment of tuberculosis of the eye with tuberculin.

Dr. King was prominent in the Cincinnati Academy of Medicine, the Ohio State Medical Society, the American Ophthalmological Society, the American Academy of Ophthalmology and Otolaryngology and the Section on Ophthalmology of the American Medical Association. He was a faithful attendant at the meetings of these societies, taking an active part in the discussion and contributing papers of decided merit.

His last paper was read before the American Ophthalmological Society in June 1936.[1] A few years ago he contributed an article on heterochromia,[2] which was the first effort in this country to separate

1. King, C.: Chronic Subdural Hematoma as a Cause of Choked Disk, Arch. Ophth. **16**:903 (Nov.) 1936.

2. King, C.: Tr. Am. Ophth. Soc. **14**:339, 1927.

the group of conditions included under that title. Another important contribution dealt with the use of tuberculin in the various forms of tuberculosis of the eye.[3]

I have suggested Dr. King's personal charm, innate courtesy and kindness. Perhaps these will be better explained to those who had not the good fortune to know him by saying that the tribute of Halleck to his friend Drake, "None knew thee but to love thee nor named thee but to praise," can be appreciated fully by those who knew Clarence King.

R. I. LLOYD.

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3. King, C.: Therapeutic Value of Tuberculin in Ophthalmology, Arch. Ophth. **1**:713 (June) 1929.

R. H. ELLIOT, M.D., F.R.C.S.

Lieutenant-Colonel I.M.S. (Ret.)

1864—1936

Robert Henry Elliot, the son of a colonel in the army, studied medicine at St. Bartholomew's Hospital, from which he graduated brilliantly with many honors. After entering the Indian Medical Service in 1892, he obtained civil employment in Madras in 1894 and worked in various capacities until he became, in 1904, the superintendent of the Government Ophthalmic Hospital in Madras and professor of ophthalmology in the Madras Medical School. He was instrumental in raising this hospital to a leading position in the study and treatment of diseases of the eye. Here he had the opportunity of making his name world known in his chosen specialty, particularly in connection with the operation for sclerocorneal trephining in chronic glaucoma.

In 1914 he returned to England on account of ill health and started an active practice in London. He continued his literary activities, became lecturer on ophthalmoscopy at the London School of Hygiene and Tropical Medicine and delivered the Hunterian Lecture for 1916-1917 before the Royal College of Surgeons. While in London, as a member of the Council of the British Medical Association he was instrumental in bringing about many needed reforms in the Indian Medical Service. In addition to being an indefatigable worker, Elliot wrote with great facility and clarity. Among the many books from his pen "Glaucoma" and "Tropical Ophthalmology" are best known.

The operation of trephining in chronic glaucoma, which is practiced all over the world and is known as the Elliot operation, did much to remedy that dreaded disease and save many sufferers from blindness. According to Kirkpatrick,[1] Elliot "recognizing the value of Lagrange's work on this subject set himself to devise a safer method of securing a filtering cicatrix, and evolved the idea of removing subconjunctivally with a trephine, a disc of the sclero-corneal tissue." The success which this operation had in checking the progress of chronic glaucoma gave a renewed impetus to the study of this disease, and in Elliot's "A Treatise on Glaucoma" the reader will find the subject treated in a complete and scientific manner.

Elliot visited the United States in 1913 and demonstrated his operative technic in various ophthalmic hospitals. He contributed a number of articles to the ARCHIVES, the last on "Trephining,"[2] in which he

1. Kirkpatrick, Henry: Brit. M. J. **2**:1062 (Nov. 21) 1936.
2. Elliot, R. H.: Trephining, Arch. Ophth. **8**:797 (Dec.) 1932.

emphasized various points in this operation which make for success and which bear constant repetition.

At the Seventeenth International Congress of Medicine in 1913 he was a reporter on the subject of glaucoma.

Elliot's interests, outside of ophthalmology, were snakes, to which he had devoted much study, and magic; a remarkable book by him on the latter subject, "Myth of the Mystic East," appeared in 1934.

His wife, who had been a great help to him in his scientific investigations and writings, died eleven years ago. Three sons survive.

ARNOLD KNAPP.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

FORMATION OF SYNECHIAE BETWEEN THE MARGIN OF THE OPTIC CUP AND THE LENS IN THE EMBRYO. T. A. Vos, Klin. Monatsbl. f. Augenh. **96:** 452 (April) 1936.

Two intra-ocular formations occurring in microphthalmos are described: a membrane between the ciliary body and the posterior surface of the lens, and a similar membrane connecting the retina and the lens. Eight selected cases are reported and well illustrated. Vos found that the membrane between the lens and the inner surface of the eyeball consisted either of a predominantly uveal or a predominantly retinal derivative. The mechanism is represented by an embryonal synechia between the lens and the margin of the optic cup. Isolated degeneration of the latter is considered the cause of this formation of a synechia. In this connection an eyeball is described which presented a congenital connection between the lens and a posterior portion of the retina. Vos compares this connection with a formation of folds described by several authors as ablatio falciformis of the retina. Incidental findings were colobomas, fibrous "apparent" lenses, cysts of the iris and circular detachment of the retina with the optic nerve drawn inside the eyeball. Vos considers it possible that the presence of the synechia may form an opportunity for voidance of the hyaloid artery, leading to its preservation.

K. L. STOLL.

THE ANATOMY OF ZINN'S RING. A. VILA-CORO, Klin. Monatsbl. f. Augenh. **96:** 477 (April) 1936.

Vila-Cora proves by his research and by detailed anatomic description that Zinn's ring is a slit. He suggests that one ought to term the passage from the orbit into the interior of the skull not "Zinn's ring," but "Zinn's canal" or, still better, "Zinn's slit."

K. L. STOLL.

Bacteriology and Serology

POSTOPERATIVE ENDOGENOUS INFECTIONS OF THE EYE. D. KRAVITZ, Am. J. Ophth. **19:** 328 (April) 1936.

Kravitz reports the extraction of a cataract in which delivery of the lens was very difficult, as though it were held down below, and when delivered it showed a small amount of soft whitish exudate at its lower pole. Two days later there was pus in the anterior chamber, and a smear showed numerous extracellular and intracellular organisms, which the pathologist diagnosed as gonococci. On being questioned,

the patient finally recalled a gonorrheal urethritis that occurred 60 years before, when he was aged 18. The infection continued, and the eye finally became phthisical. A complement fixation test was negative. He quotes various authors and speculates on the possibility of these infections lying dormant for long periods. W. S. REESE.

Biochemistry

THE CIRCULATION OF BLOOD IN THE EYE AND VITAMIN C. W. BUSCHKE, Arch. f. Augenh. **109:** 691, 1936.

The amount of cevitamic acid in the aqueous depends on the amount of the oxidized form of vitamin C in the blood. The vitamin C coming from the blood is reduced by the lens to cevitamic acid. This acid cannot get back into the blood stream because normally the blood-aqueous barrier is impermeable to its passage. If, however, as numerous experiments have proved, this barrier is made more permeable, as by subconjunctival injections of salt solution, the amount of cevitamic acid in the aqueous falls. Further, if the vitamin C in the blood is increased by feeding or by intravenous injection of a synthetic preparation of vitamin C, the cevitamic acid in the aqueous rises. This demonstrates the interesting fact that the lens not only can reduce ordinary amounts of vitamin C presented to it normally but has the capacity to take care of considerably larger quantities when these occur under experimental conditions.

Three factors are of importance in determining the quantity of cevitamic acid in the aqueous: (1) the size and blood flow of the uveal capillaries, (2) the permeability of the capillary walls for vitamin C and (3) their permeability for cevitamic acid.

The third factor was investigated in previous papers (Goldmann and Buschke: *Arch. f. Augenh.* **109:** 314, 1935). The present communication deals with variations in the first two factors. These two factors cannot at present be separated. The authors therefore elected to use drugs which increase and decrease the size and the permeability of the capillaries of the uveal tract, i. e., acetylcholine and epinephrine.

In a series of rabbits a subconjunctival injection of epinephrine was given in one eye, followed at regular intervals by drops of epinephrine in the conjunctival sac, and 100 mg. of a synthetic preparation of vitamin C was given intravenously to raise the vitamin C content of the blood. The cevitamic acid content of each of the eyes was then determined. As was to be expected, the control eye contained much more cevitamic acid than the eye treated with epinephrine. They ascribe this effect to diminution in the supply of vitamin C reaching the anterior chamber of the treated eye—hence, less for the lens to convert into cevitamic acid. They do not decide whether the widely dilated pupil in the eye treated with epinephrine was a factor in producing this effect or not.

In a second series of rabbits acetylcholine was injected subconjunctivally in one eye, and at varying periods the cevitamic acid contained in each anterior chamber was determined. In the majority of the experiments a considerable increase in the cevitamic acid content of

the eye treated with acetylcholine was found, but the effect was not constant, and in one case a lower content of cevitamic acid was found. There seemed to be a more or less general agreement between the increase in cevitamic acid and the degree to which the capillaries retained their normal impermeability, for when the protein in the aqueous was found to be high after the use of acetylcholine (this was used as an index of increased permeability of the uveal capillaries) the cevitamic acid was not increased. Acetylcholine, according to these authors, must therefore have some peculiar effect on the eye which leads to an increase in cevitamic acid, besides its effect in increasing the permeability of the walls of the blood vessels. This action may be an increase in the blood flow through the uveal capillaries, which brings a greater amount of vitamin C into the anterior chamber. Here it is changed into cevitamic acid, and in this form it cannot escape from the anterior chamber back into the blood stream.

A discussion of technical points follows to prove that the effects the authors observed are in reality due to changes in the intra-ocular circulation.

F. H. ADLER.

Color Sense

ANOXEMIC COLOR FATIGUE: A LATENT DISTURBANCE OF THE COLOR SENSE. K. VELHAGEN, Arch. f. Augenh. **109:** 605, 1936.

A group of persons possessing normal color vision were subjected to reduced barometric pressures in a pressure chamber and their color vision tested with the anomaloscope. Readings were taken at pressures corresponding to sea level, 3,000, 5,000 and 6,000 meters of altitude. The effect of lowered oxygen tension at normal barometric pressure was not investigated.

It was found that a number of persons show no change in their color perception at high altitudes, but that a greater number show a considerable reduction in their discrimination for colors and brightness. In some persons who have normal color vision at normal barometric pressure a definite disturbance in color vision develops which simulates that of a congenital anomalous trichromat. Further, anomalous trichromats can be changed to dichromats by reducing the barometric pressure.

The significance of these changes is discussed, and their importance in aviation is pointed out.

F. H. ADLER.

Cornea and Sclera

TATTOOING OF CORNEAL OPACITY WITH GOLD AND PLATINUM CHLORIDE. J. N. DUGGAN and B. P. NANAVATI, Brit. J. Ophth. **20:** 419 (July) 1936.

In twenty-nine cases corneal opacities were tattooed with gold chloride. The following summary is substantially that given by the authors:

In twenty-five cases the opacities were tattooed with gold chloride and tannin, and in four, with gold chloride and hydrazine hydrate, with fairly good cosmetic results. Tattooing with tannin, which produced

a brown tint, was more painful than that with hydrazine hydrate, which gave a black color.

A slightly acid 4 or 5 per cent solution of gold chloride was applied to the denuded surface of the leukoma for four or five minutes. The strength of the tannin was 1 per cent, while that of the hydrazine hydrate was 2 per cent.

In vascular leukoma the color obtained in tattooing by either method slightly faded and partly disappeared in some cases, in which a second operation was required.

In fourteen cases the opacities were tattooed with a freshly prepared 2 per cent solution of platinum chloride and a 2 per cent solution of hydrazine hydrate. The color obtained was jet black.

Iridectomy could be done either before or after tattooing by either method.

Of the cases reported in this article, two are of special interest. In one, an opacity which was tattooed with gold chloride and tannin showed a fairly good cosmetic effect even after two years, while in the other case, in which an opacity was tattooed with platinum chloride and hydrazine hydrate, the slightly faded black color had remained unchanged for five years.

W. ZENTMAYER.

A CASE OF SCLEROSING KERATITIS PROFUNDA. A. VISWALINGAM, Brit. J. Ophth. **20:** 449 (Aug.) 1936.

The patient was a man aged 59 who had had renal calculi. The corneal condition was symmetrical, involving both eyes, and was accompanied by attacks of intermittent bulbar congestion lasting from twenty-four to forty-eight hours. With the attacks of congestion, calcium oxalate crystals were found in the urine. Later attacks of secondary glaucoma supervened. The left eye became blind and painful and was enucleated. A detailed pathologic report on the eye is given by Stallard. The corneal lesion had predominant inflammatory characters; such degenerative changes as were present were probably secondary to these. The article is illustrated.

W. ZENTMAYER.

SPECTROGRAPHIC STUDY OF THE KAYSER-FLEISCHER CORNEAL RING. A. POLICARD, P. BONNET and G. BONAMOUR, Compt. rend. Soc. de biol. **122:** 1120, 1936.

The greenish ring of the cornea characteristic of Wilson's disease (hepatolenticular degeneration) was submitted to histospectrographic study according to Policard's special technic. Copper was noted in an appreciable amount, but no silver, iron or zinc. The copper of the corneal ring is undoubtedly associated with the sclerotic liver observed in patients with this disease.

J. E. LEBENSOHN.

Experimental Pathology

THE SERUM LIPASE IN NAPHTHALENE CATARACT. D. MICHAIL and I. PACURARIU, Compt. rend. Soc. de biol. **122:** 1125, 1936.

In rabbits given naphthalene the lipase of the blood serum diminishes, reaching its lowest point when the opacity of the lens becomes

total. Thereafter the lipase rises slowly but does not again attain its normal level for from four to five months. The lipase of the lens and retina is probably similarly affected. This suggests that a pancreatic disease affecting the production of lipase may be at the basis of certain senile cataracts, especially when these are associated with diabetes.

J. E. LEBENSOHN.

General

OPHTHALMOSCOPIC SIGNS OF DEATH. C. R. SALSBURY and G. S. MELVIN, Brit. M. J. **1:** 1249 (June 20) 1936.

Salsbury and Melvin have established by clinical and experimental observations that in life the movement of the column of blood in the retinal veins is visible. As death approaches, the stream becomes slightly irregular and lumpy. Later (with cessation of cardiac activity) there is fragmentation of the column, the masses of blood moving toward the optic disk and then dropping over the edge of the optic cup. This movement is visible for from ten to twelve minutes. After all movement of the blood has ceased, the interrupted columns are visible as long as the media remain transparent.

This movement of blood in the veins is ascribed to an equalization of pressure between the arteries and veins, due to isolated arterial contractions.

This test has frequently been applied to patients in profound shock, but always with negative results. No patient in whom this phenomenon has been observed has subsequently shown the slightest evidence of life.

The conclusions are: 1. If the retina appears as in life, the heart is still functioning, and artificial respiration is indicated. 2. If this movement of the blood in the veins is visible, the heart has stopped for not more than fifteen minutes; attempts at resuscitation are indicated, but the prognosis is bad. 3. If fragmentation is visible and all movement of the venous blood has ceased, recovery is probably impossible.

W. F. DUGGAN.

BIOLOGIC ACTION OF DIFFERENT FORMS OF RADIANT ENERGY ON OCULAR TISSUES. G. LEPLAT, Ann. d'ocul. **173:** 433 (June) 1936.

Leplat refers to the fact that Strohl a little over a year ago dealt with this subject before the Ophthalmological Society of Paris.

Besides roentgen rays and the radiations of radioactive bodies, other forms of radiant energy interest ophthalmologists either because they are used in therapeutics or because they are the cause of ocular lesions the mechanism of which is still in controversy. The question of so important a matter as glassblowers' cataract and of the action of infra-red rays is still much debated.

The author's subject is divided into: the different forms of radiant energy and the conditions of their action; the absorption of radiant energy by the ocular tissues; the action of radiant energy on the ocular tissues; the action of infra-red rays; the effects of heat and the action of ultraviolet rays and the action of roentgen rays and of radium on the ocular tissues.

S. H. MCKEE.

General Pathology

A Method to Keep Explanted Lenses Alive. A. Bakker, Arch. f. Ophth. **135:** 581 (July) 1936.

The work reported in this paper was done in the physiologic institute of the University of Gröningen, and a method devised by the director of this institute, de Haan, was used. The lenses of adult rabbits were removed under sterile conditions and transferred to shallow water-tight, air-tight glass chambers which permitted microscopic examination through their walls. A slow but constant stream of a nutritive fluid was led through each chamber. As the nutritive fluid, Bakker used the abdominal fluid which rabbits produce on intraperitoneal injection of large amounts (from 750 to 1,000 cc.) of Ringer's solution. The composition of this fluid, which really is a very dilute exudate, resembles that of normal aqueous. Before it entered the glass chambers carrying the lenses, it was saturated with air. Its gas content after it had passed through a chamber permitted calculation of the consumption of oxygen by the lens. Under the conditions of these experiments, the consumption of oxygen and dextrose, the macroscopic and microscopic appearance and the response to injuries of the capsule of the lens of the mature rabbit remained normal for several days, which facts indicate that the lens was kept alive.

P. C. Kronfeld.

Glaucoma

Relations Between Obstruction of the Central Retinal Vein and Glaucoma. J. Krause, Arch. f. Ophth. **135:** 173 (March) 1936.

Krause reviews the work of Harms, Coats, Verhoeff, Scheerer, von Hippel and Kiel and Salzmann on primary glaucoma leading to obstruction of the central vein and on obstruction of the central vein leading to secondary glaucoma. Krause himself has studied anatomically twenty eyes which were enucleated because of absolute glaucoma. Only sixteen of these eyes exhibited pathologic changes of the central retinal vein. The vein was always greatly narrowed; often its wall was indented and the lumen filled with endothelial cells, fibrocytes and a network of fibers. A true thrombosis could not be diagnosed with certainty in a single case. Krause's observations were not essentially different from those of the aforementioned authors. He discusses a number of well known factors, and also a few new ones which predispose the intralaminar portion of the retinal vein to obstruction.

P. C. Kronfeld.

Provocative Tests for Glaucoma: The Intermittent Glaucoma. G. Ohm, Arch. f. Ophth. **135:** 537 (July) 1936.

"The glaucomatous eye is characterized not only by high intra-ocular tension but also by ready fluctuation of tension. This instability of tension is known to occur very frequently in the otherwise healthy mate of a definitely glaucomatous eye." Ohm (with the ophthalmologic clinic of the University of Berlin) used the following provocative tests:

the drinking test of Marx, the caffeine test and the dark-light test. The material consisted of eighteen cases of primary glaucoma, seven of secondary glaucoma, six of pseudoglaucoma, two of instability of tension without other signs of glaucoma and thirteen control cases. The diurnal variations of tension were recorded before making the tests. During the course of the drinking test and the caffeine test, but not of the dark-light test, even the controls showed elevation of tension up to 30. Primary glaucoma always reacted more strongly than secondary glaucoma. The reaction to the dark-light test was less pronounced than that to the other two tests. It did not seem to depend on the depth of the anterior chamber.

As instances of intermittent glaucoma the author describes cases in which the response to provocative tests varied from one time to another. The eyes were definitely glaucomatous. The reviewer doubts the appropriateness of the term "intermittent" for glaucoma of this description.

As examples of pseudoglaucoma were classified six cases with glaucomatous excavation, atrophy of the optic nerve and defects of the visual fields but with normal tension and normal response to the provocative tests. In three of these cases deposits of lime were visible roentgenologically in the region of the intracranial portion of the internal carotid artery. In one of these cases high intra-ocular tension was shown on several occasions.

As a practical procedure to diagnose early glaucoma, he recommends, first, study of the diurnal fluctuations; if these are slight, the drinking and the caffeine test are indicated. Since the response of normal eyes to these tests is only quantitatively different from that of glaucomatous eyes the disturbance which underlies glaucoma must be an ocular one.

P. C. KRONFELD.

Hygiene, Sociology, Education and History

DEFUNCT LONDON EYE HOSPITAL. A. SORSBY, Brit. J. Ophth. **20: 77** (Feb.) 1936.

This lengthy historical article does not lend itself to abstracting. The reader, however, will find himself repaid by reading it.

W. ZENTMAYER.

THE CINEMATOGRAPH AND THE VISUAL APPARATUS. J. A. GALLINO, Arch. de oftal. de Buenos Aires **10: 365** (June) 1935.

This detailed official report based on the statistics of the Educative Cinema Institute of Italy and on the opinions of several Italian, French and Dutch ophthalmologists specifies the apparatus to be employed and the classroom conditions requisite for the proper use of the cinematograph in school teaching.

Gallino reaches the following conclusions: 1. The cinematograph is not injurious to the eyes of school children if their eyes are sound. 2. Its employment should be barred for children with myopia, astigmatism of high degrees, disturbances of accommodation and of binocular

vision, muscular insufficiencies and active ocular disease. 3. There is no objection to its employment for children whose refractive defects are corrected. 4. The duration of each part should not exceed a period of from ten to fifteen minutes, the interval between the parts being from two to three minutes. 5. The screen should be located at a distance of 5 meters from the children. 6. The illumination of the room should be so arranged that the transitions are gradual, and a slight general illumination is convenient during the projection of the film. 7. The condition of the films and of the apparatus should be periodically inspected by experts. 8. The total duration of the filming should be limited to one hour. 9. The apparatus should be simple, of low cost and durable.

C. E. FINLAY.

Injuries

OCULAR LESIONS DUE TO HIGH FREQUENCY CURRENTS. O. BARRATTA, Ann. di ottal. e clin. ocul. **64:299** (May) 1936.

Barratta observed three cases of ocular lesions due to high frequency currents. In all three cases there were localized burns about the eye as a result of the current. In the first case the vision began to diminish immediately after the accident, and after four months the right eye showed a complete cataract, which had swollen so as to abolish the anterior chamber and cause secondary glaucoma. The left crystalline lens at this time showed some punctate opacities. The lens of the right eye was removed following an Elliot trephining, resulting in vision of 1/10. In the left eye the opacities progressed slowly, not requiring operation until three years later, when a good result was obtained.

The second case was observed three months after the accident, when vision was reduced to 1/10 in each eye. The lens opacities affected the anterior cortex and posterior cortex just under the capsule, the nucleus being clear. Nine months after the accident the lenses were almost completely opaque.

The third case was interesting, as only a localized opacity in the lens was present after fourteen months. This affected the anterior cortex in a sector running out from the center of the lens. There were also a few subcapsular vacuoles on the nasal side. Vision was reduced to 6/10. Two months later the vision had improved to 10/10, although the appearance of the lens opacities was about the same. This patient also showed miosis on the side of the lens opacities, which by pharmacologic tests the author proved was due to paralysis of the sympathetic nerve endings in the iris.

A bibliography accompanies the article.

S. R. GIFFORD.

MAGNETIC INTRA-OCULAR FOREIGN BODIES AND EXTRACTION WITH THE ELECTROMAGNET. J. SELLAS, Arch. de oftal. hispano-am. **36: 17** (Jan.) 1936.

Sellas' statistics of incidence from 1925 to 1934 yielded only 2.5 per thousand; he considers the occurrence rare. The diagnosis is generally easy; exceptionally, however, the insignificance of the injury, its situation, the presence of other lesions or processes, the existence of

inflammatory exudates and a defective history cause the foreign bodies to be overlooked. Whenever there is the slightest doubt roentgen examination is indispensable. For the localization of such bodies Sellas employs a simple method involving subconjunctival introduction of leaden threads. The prognosis is always serious, Sellas' statistics indicating loss of sight in 44 per cent of the cases, and those compiled from several other authors, in 43.5 per cent. As to treatment, he considers as early as possible extraction of the foreign bodies most urgent. When they are localized in the anterior segment of the eyeball they should be removed through the original wound or, if this is closed, through a keratome incision; those in the posterior segment he is inclined to extract through a scleral incision. Except in cases in which the situation is very superficial, in which a hand magnet can be used, he employs a giant magnet, his own model, constructed on the lines of Haab's. In the treatment of the coexisting inflammatory conditions he uses protein therapy, subconjunctival and intravenous injections of mercuric cyanide, autohemotherapy and the usual local medication. The resulting lesions, such as traumatic cataract, he treats on the usual lines.

Appended to the paper is a detailed statistical report of fifty-nine cases. In 44 per cent of the cases there was loss of vision, in 23.72 per cent recovery with normal vision and in 32.88 per cent recovery with reduced vision.

C. E. FINLAY.

A RARE LESION OF THE EYE AFTER TREATMENT WITH ROENTGEN RAYS. A. PILLAT, Klin. Monatsbl. f. Augenh. **94:** 384 (March) 1935.

A woman aged 51 was treated with roentgen rays for a retrobulbar tumor. Crossed rays were applied from three fields of entrance, each field receiving 7,000 superficial roentgens. Two years later a typical posterior rosette cataract developed, which was followed by general opacification of the lens. After extraction of the cataract a change resembling disciform degeneration was found in the macula; it was surrounded by a circle of small retinitic foci. The fundus of the second eye was free from pathologic change.

K. L. STOLL.

Instruments

A PORTABLE SCOTOMETER, J. P. S. WALKER, Brit. J. Ophth. **20:** 466 (Aug.) 1936.

The apparatus folds into a case in which there is room for spare charts and the rod carrying the "moving spots." There is also a chin rest. The chart holder has a small hole in the center, behind which there is a small electric bulb. The chart also contains a center hole. The chart is inserted with a matt black surface toward the patient. The moving spot of light is obtained by means of a rod on the tip of which is a small hole. Behind this is a rotating disk with colored glasses, transilluminated by a pocket battery in the handle. Behind the hole is a pinpoint with a spring guard, and below it is a square block of metal. The rod is placed over the chart, keeping the block in contact

with the chart. As soon as the patient says that the light has gone, a slight pressure against the chart with the rod will bring the pinpoint into action and a prick will be made on the chart.

The article is illustrated.

W. ZENTMAYER.

Lens

"POSTERIOR NEEDLING" IN THE TREATMENT OF LAMELLAR AND OTHER FORMS OF SOFT CATARACT. A. J. BALLANTYNE, Brit. J. Ophth. **20:** 540 (Sept.) 1936.

Ballantyne states that the operation described has been practiced in Glasgow for many years. The usual preparation of the eye is made, and the pupil is dilated with atropine. Cocaine and epinephrine are used to obtain anesthesia. The room should be darkened and focal illumination secured by means of a hand lamp. Any sharp knife needle may be used. The needle is passed through the sclera below the tendon of the external rectus muscle and 5 mm. from the corneoscleral junction, its point being directed into the vitreous forward to the posterior pole of the lens. Then, by carrying the handle of the needle backward in the direction of the temple, the point is turned forward and can be seen to enter the substance of the lens. A criss-cross incision is made in the posterior capsule and cortex of the lens, and the needle is withdrawn in the reverse of the direction of entry. Naturally the operation occupies only a fraction of the time required to describe it. The eye is usually bandaged for the first twenty-four hours, after which the bandage can be removed. Atropine is continuously applied.

While there may be some uncertainty as to the result of a single needling, and it usually has to be repeated, one can be certain that the patient will be spared the suffering incident to the occurrence of iritis and secondary glaucoma. The patient may be treated as an outpatient.

To the author's knowledge, in only one case was a detachment of the retina discovered, and this was some years after the operation.

W. ZENTMAYER.

ASTIGMATISM OF THE LENS. Y. SHOJI, Ann. d'ocul. **173:** 467, 1936.

The crystalline lens is not a perfect unit in an optical sense, as the index of refraction varies. The pupil is much smaller than the diameter of the crystalline lens, and the light rays that traverse the periphery of the lens are intercepted by the iris screen.

Astigmatism of the cornea is daily met with, and one understands without difficulty that all astigmatism is due to the cornea. However, in the presence of a cataract one often notes an irregular astigmatism due to modifications of the lens. The encyclopedia notes astigmatism of the lens briefly, but in practice not much attention is paid to it.

In a period of five years Shoji met with three cases of regular crystalline astigmatism, and he recently observed another case discovered by one of his colleagues.

The degree and axis of the crystalline astigmatism does not always accord with those of the corneal astigmatism. The glasses preferred by

patients do not always accord with those determined by optical examination. The visual clearness obtained with corrective glasses does not always reach normal.

The details of four cases are given in tabular form.

S. H. McKee.

Demonstration of Latent Dystrophy of the Crystalline Lens in Avitaminosis. C. G. Mouriquand and J. Rollet, Compt. rend. Soc. de biol. **122**:1118, 1936.

In scorbutic guinea-pigs corneal paracentesis induces within twenty-four hours minute foci of cloudiness in the lens, visible with the slit lamp. If the animals are then given vitamin C, the mottling disappears completely, but if the administration of the vitamin is delayed three days, the lesions tend to persist.

J. E. Lebensohn.

Principles Involved in the Extraction of Cataracts. E. Seidel, Arch. f. Ophth. **135:** 159 (Jan.) 1936.

Seidel believes that postoperative iridocyclitis is not caused by lens matter left in the eye but by infection, and that the shock of the operation can be lessened by more complete anesthesia and by shortening and simplifying the surgical procedure. His procedure is as follows: maximum dilation of the pupil with atropine; repeated instillation of 10 per cent cocaine; fixation of the globe just below the counterpuncture; large (over two-fifths) limbic incision with formation of a conjunctival flap continuous with the cornea; removal of a big piece of lens capsule; expression of the nucleus and of what cortex comes out with it; no scooping out of the remnants and no iridectomy; instillation of 1 per cent physostigmine. The author has had only 2 prolapses of the iris in 140 extractions. He stresses the dangers of the intracapsular method.

P. C. Kronfeld.

Methods of Examination

Kinescopy — Objective and Subjective (Supplementary Remarks). S. Holth, Brit. J. Ophth. **20:** 412 (July) 1936.

These are brief supplementary remarks to the author's earlier paper (*Brit. J. Ophth.* **19**:603 [Nov.] 1935). It is not possible to abstract this short paper satisfactorily. It should be read and compared with the original paper.

W. Zentmayer.

The First Radius-Figure for Subjective Astigmometry. S. Holth, Brit. J. Ophth. **20**:415 (July) 1936.

This is a brief historical memorandum calling attention to the radius figure for estimating astigmatism at near distance first published by Javal in 1865. The examination was made binocularly with two objects, namely, a circle before one eye and radiating lines before the other; the intention of the procedure was to suspend convergence and accommodation, making atropine superfluous. It is this radius figure, magni-

fied for the distance of 6 meters and surrounded by the clock periphery (radiating lines for every hour and for every half hour), which even today is used by nearly all oculists for subjective astigmometry.

W. ZENTMAYER.

A PHOTO-ELECTRIC METHOD TO STUDY THE OXYGEN CONTENT OF THE BLOOD IN THE EYE. G. SCHUBERT, Arch. f. Ophth. **135:** 558 (July) 1936.

A photo-electric cell sensitive to red rays is put opposite the dilated pupil of a rabbit's eye, which is illuminated disclerally by means of the Lange lamp. The photo-electric cell is connected with a sensitive galvanometer, which registers a current that depends on the amount of light emitted by the rabbit's fundus. Shutting off the oxygen to the rabbit lowers the intensity of this current, while slowing the retinal circulation increases the current. Schubert recommends this method for determining the degree of the oxygen saturation of the blood in the eye.

P. C. KRONFELD.

Neurology

CILIARY (MIGRAINOUS) NEURALGIA AND ITS TREATMENT. WILFRED HARRIS, Brit. M. J. **1:** 457 (March 7) 1936.

Ciliary neuralgia is a form of migrainous neuralgia in which the pain is located in or about the eyeball. In addition, the eye may become extremely congested and reddened and show lacrimation. The neuralgia is usually recurrent. It affects the temple and side of the forehead and extends to the back of the head. The pain is intense and excruciating. It may last for from ten minutes to thirty hours. Nausea occasionally accompanies the pain, but visual spectra and transient hemianopia are absent. The condition can be helped and attacks arrested for months or years by injecting alcohol into the supra-orbital or intra-orbital nerves; an injection into the gasserian ganglion, which produces permanent trigeminal anesthesia, is more apt to give a lasting result. This condition should be distinguished from trigeminal tic involving the ophthalmic division of the fifth cranial nerve and chronic neuralgia of the jaw. Other painful conditions in the region of the eye which must be distinguished are glaucoma, herpes frontalis and leaking aneurysm of the circle of Willis (Bramwell, Edwin: *Tr. Ophth. Soc. U. Kingdom* **54:** 205-221, 1934).

Harris believes that migrainous neuralgia is due to vasomotor influences on the dural blood vessels, especially on the middle meningeal artery.

He has observed twenty-three cases of ciliary neuralgia, which occurred practically in all periods of life, perhaps most frequently in that between 40 and 50 years. The onset of pain is usually in the early hours after midnight. In ten of these cases the painful eye was red and intensely congested, often showing lacrimation.

Harris concludes with the following summary: "Migrainous neuralgia is a substituted form of migraine, in which the pain is referred

anteriorly into the temple, eye, cheek and jaw. It is usually strictly unilateral, though occasionally it may pass over the opposite side at the end of an attack, as in migraine, another point of resemblance being the not uncommon presence of nausea. There are never present any of the cerebral phenomena of teichopsia, hemianopia, aphasia, or monoplegia. This difference in its symptoms may be due to vasomotor spasm affecting blood vessels of the dura, such as the middle meningeal instead of the posterior cerebral artery as in migraine, the pain in migrainous neuralgia being referred along the recurrent trigeminal meningeal branches. Such a view of its pathology would account for the good effect undoubtedly produced in many cases of severe migrainous neuralgia by alcohol injection of the supra-orbital or infra-orbital nerves, or by injection of the inner two-thirds of the Gasserian ganglion, which produces a more lasting cure. In many cases the duration of the paroxysms may be as short as ten minutes or a quarter of an hour, sometimes from four to six attacks occurring in the twenty-four hours. It is such brief attacks that might possibly lead to confusion of the diagnosis with trigeminal tic. In certain cases of migrainous neuralgia the pain is especially referred into the eyeball and around the eye, and in a large proportion, nearly 50 per cent, the eye becomes very congested with lacrimation—a veritable ocular crisis."

A. KNAPP.

Operations

CORRECTION OF PTOSIS BY TWO STRIPS OF FASCIA LATA. J. A. MAGNUS, Brit. J. Ophth. **20**:460 (Aug.) 1936.

Magnus describes the operation introduced by Lexer of Munich in 1923 (*Klin. Monatsbl. f. Augenh.* **70**: 464, 1923). The advantage of Lexer's technic is that a direct connection is made between the frontalis muscle and the lid margin by a tissue which can be left in place. In time the tissue undergoes a natural contraction which emphasizes the effect of the operation. For practical purposes the article should be consulted, as it is illustrated.

W. ZENTMAYER.

KERATOPLASTIC REPARATION OF THE ENTIRE CORNEA. R. FRIEDE, Arch. f. Augenh. **109**: 662, 1936.

Friede reports six cases in which he transplanted a large piece of cornea from one human being to another, with results which satisfied him that the procedure was feasible. Some of the transplanted pieces of cornea were taken from postmortem material. Every patient treated had a total leukoma, and from 9 to 11 mm. of the opaque cornea was excised with a trephine and replaced with a transplant of similar size, similarly excised. The technical details are given in full, with a general discussion of corneal transplantation. The protocols do not announce any improvement in visual acuity, but Friede believes that this procedure may save eyes that have perception of light with total leukoma from eventual enucleation. In most of the cases previous keratoplastic operations had been performed without success.

F. H. ADLER.

Orbit, Eyeball and Accessory Sinuses

THE CAUSE OF VOLUNTARY FORWARD LUXATION OF THE EYEBALL. D. J. LYLE and J. S. MCGAVIC, Am. J. Ophth. **19:** 316 (April) 1936.

The authors review the literature and report the case of a colored man who could voluntarily luxate the right eye. He died of pneumonia, and an autopsy was secured. The left orbit was found to be normal. In the right the superior oblique muscle was found to bifurcate, the lower branch going to its normal insertion while the upper was attached to the superior rectus muscle 10 mm. behind its normal insertion. In the lower part of the orbit was a protractor muscle, which arose just behind the orbital tubercle and was inserted in the posterior part of the globe.

W. S. REESE.

GRANULOMA OF THE BULBAR SUBCONJUNCTIVAL TISSUE ARISING FROM AN EMBEDDED CILIUM. F. W. G. SMITH, Brit. J. Ophth. **20:** 455 (Aug.) 1936.

The patient was a woman aged 66 years. There was no history of injury, and the condition had been diagnosed as episcleritis. There was a localized swelling, solid and slightly gelatinous in part. It was beneath the conjunctiva. A number of large vessels radiated from the growth. With the loupe a body of different refractive index was seen in the gelatinous portion and proved to be a cilium, one of her own. The article is illustrated.

W. ZENTMAYER.

Pharmacology

SYNTHETIC SUPRARENIN BITARTRATE AS A MYDRIATIC. W. D. HORNER and J. BETTMAN, Am. J. Ophth. **19:** 311 (April) 1936.

The literature on epinephrine and substitutes for it is reviewed especially as to the clinical uses and physiologic effects. Following the use of suprarenin bitartrate on seventy-four patients in a home for the aged the following conclusions were reached:

1. For ophthalmoscopic work, 2 drops of 2 per cent bitartrate are sufficient and will not only dilate the pupil as much and as rapidly as a larger dose but may be easily controlled by physostigmine. This dose would seem ample for mydriasis except when adhesions of the iris must be broken up.

2. The amount of the drug has little influence on the speed of dilatation.

3. Mydriasis from 2 drops lasts half again as long (twelve and three-quarter hours) as that from 1 drop (eight and a half hours); 4 drops give the same result as 2 drops.

4. A pupil dilated with 2 drops of this drug will return to normal in about twenty-five minutes if 1 drop of physostigmine is instilled twice at ten minute intervals.

5. Headaches are common after administration of suprarenin bitartrate (in 54 per cent of the cases in the authors' series) and are more severe when physostigmine is used in combination with it.

6. A combination of suprarenin bitartrate and powdered atropine is recommended when a supermydriatic is desired.

W. S. REESE.

INHIBITION OF EPINEPHRINE AUTO-OXIDATION BY AQUEOUS. F. BONHOMME, Compt. rend. Soc. de biol. **122:** 110, 1936.

Epinephrine hydrochloride (1 : 100,000) buffered at p_H 6.77 oxidizes rapidly in air; in a few minutes some coloration appears; in one hour, definite redness. After nineteen hours the preparation is totally inactive, whereas the same concentration of epinephrine in aqueous similarly buffered and exposed has conserved most of its biologic potency. Blood plasm has an even greater protective action than aqueous. The preservative properties seem largely due to the proteins present, not to vitamin C or other reducing agents.

J. E. LEBENSOHN.

The Pupil

THE AMAUROTICALLY FIXED PUPIL: I. ITS USE AS A PHARMACOLOGIC TEST OBJECT. F. POOS and H. GROOSE-SCHÖNEPAUCK, Arch. f. Ophth. **135:** 144 (Jan.) 1936.

In studying the effect of drugs and of endogenous factors such as the carbon dioxide tension or the epinephrine content of the blood, it is always difficult to keep the other factors which influence the width of the pupil unchanged. Besides, the double innervation of the sphincter introduces a certain factor of ambiguity in that, for instance, dilation of the pupil may be the result either of a lowered parasympathetic or of an increased sympathetic tone. In other words, for experimental purposes simplification of the normal pupillary mechanism is desirable. The simplification introduced by the authors of the paper under review is unilateral amaurotic fixation, produced by transclerally destroying the retina around the disk with a small curet. This amaurotically fixed pupil is a most satisfactory pharmacologic test object, on which the effect of epinephrine, cocaine, atropine, pilocarpine and physostigmine have been studied.

P. C. KRONFELD.

Physiology

RELATIONSHIP BETWEEN THE PRESSURE IN THE VEINS ON THE NERVE HEAD AND THE PRESSURE OF CEREBROSPINAL FLUID. F. GIBBS, Arch. Neurol. & Psychiat. **35:** 292 (Feb.) 1936.

Gibbs confirms Baurmann's work by showing a direct relationship between the pressure of the cerebrospinal fluid and the pressure in the retinal veins at the optic disk. Experiments were conducted on four cats and four dogs. A hollow needle connected to a reservoir of physiologic solution of sodium chloride was inserted into the anterior chamber. By raising the level in the reservoir the intra-ocular pressure was raised until a vein on the optic nerve showed evidence of collapse.

The pressure necessary to cause partial collapse was taken as the venous pressure. The pressure of the cerebrospinal fluid was varied by means of a pressure bottle connected through a hollow needle with the cisterna magna. Alterations of cerebrospinal fluid pressure below 18 mm. of mercury did not affect the pressure in the central retinal veins, but when the pressure of the cerebrospinal fluid was raised above 18 mm. the intra-ocular venous pressure rose step by step with it, remaining from 2 to 4 mm. above it, until the pressure of the cerebrospinal fluid was greater than the intra-ocular arterial pressure.

Gibbs suggests the application of this relationship for indirect determination of high cerebrospinal fluid pressure when it seems undesirable to enter the cisterna magna or the lumbar sac. He stresses that the relationship is of theoretical interest because it shows that the pressure in veins with truly intracranial drainage varies directly, within broad limits, with the pressure of the cerebrospinal fluid. R. IRVINE.

THE CENTER OF ROTATION OF THE EYE. M. C. COLENBRANDER, Arch. f. Augenh. **109:** 622, 1936.

Colenbrander reviews the previous literature on this subject and reports his experiments to determine the center of rotation in his own eye. The visual lines plotted by his subjective method cross in the eye in an area which is 1.3 mm. high and 0.9 mm. broad. No retraction of the globe was found during the movements, and the center of rotation was proved to be not eccentric. He concludes that for all practical purposes one can assume that with the head held upright there is a simple point or center of rotation. F. H. ADLER.

A SCHEMA FOR EYE MOVEMENTS. M. C. COLENBRANDER, Arch. f. Augenh. **109:** 629, 1936.

Colenbrander assumes that the movement of the eye in any direction from any chosen position can be expressed as a rotation around three independent axes. In order to analyze the effect of each muscle in this movement, one needs to know only the position of the muscle in respect to these axes. Usually one thinks of the eye as turning in the orbit, which is stationary, but the calculations remain the same if one imagines the eye remaining stationary and the orbit turning around it. The origin of each muscle then changes its position in space, and one can then calculate this position according to Listing's law.

Colenbrander used Volkmann's figures for the origin and insertion of the ocular muscles and from his calculations arrives at the following conclusions: The two oblique muscles rotate the eye (torsion) in every position, but the torsional effect is much less when the eye is in the adducted position. The internal and external rectus muscles have a pure adducting and abducting effect only when the eyeball is in the horizontal position. When the eye is in any other position they cause either elevation or depression of the globe and also have considerable torsional effect. The superior and inferior rectus muscles cause adduction when the globe is turned in and abduction when the globe is turned out. The borderline where adduction changes to abduction depends on the degree to which the eye is elevated or depressed. F. H. ADLER.

Refraction and Accommodation

THE RELATION OF ACCOMMODATION TO THE SUPPRESSION OF VISION IN ONE EYE. G. A. FRY, Am. J. Ophth. **19:** 135 (Feb.) 1936.

This is a continuation of the work undertaken by McDougall in 1903. Fry gives the following summary and conclusions:

"The voluntary suppression or favoring of vision in one eye has been demonstrated to be mediated through changes in accommodation by showing that the voluntary control is abolished by paralyzing the ciliary muscles with homatropine. In the case of afterimages the control is brought about through changes in intraocular pressure because optical blurredness is not involved, and because it can be shown that applying pressure to one of the eyes causes the impression of that eye to predominate over that of the other eye. In the case of the rivalry of impressions produced by direct stimulation, the voluntary control is mediated through changes in the blurredness of the optical image, because voluntary control is abolished by use of a small artificial pupil, which minimizes the effects of changes in accommodation upon optical blurredness but does not interfere with proprioceptive impulses of changes in intraocular pressure."

W. S. REESE.

Retina and Optic Nerve

JENSEN'S CHORIORETINITIS. G. BOSSALINO, Arch. di ottal. **43:** 1 (Jan.) 1936.

The literature on choroiditis juxtapapillaris is reviewed, and four cases are reported. These instances occurred in young women aged from 15 to 22. In all, the characteristic fan-shaped scotoma was present, extending to the periphery and indicating a lesion involving the whole thickness of the retina, including the nerve fibers. In all, the single lesion was near the disk, the disk itself showing edema. In the first case the area of retinal edema disappeared completely in three months, leaving no visible scar, but the scotoma persisted. In the others slight pigmentary changes occurred. In two cases signs of iritis were also present with some precipitates. All active symptoms subsided in all the patients within five months, the minimal scars indicating that the lesion is primarily in the retina with very little disturbance of the pigment epithelium.

An interesting comparison is made between these cases and a case of choroiditis in which a very large lesion produced only a central scotoma, leaving the peripheral field normal.

In two of the patients with typical changes tuberculin tests were positive, and in the other the condition was considered as possibly due to tuberculosis, which is generally considered to be the commonest cause of the condition.

S. R. GIFFORD.

LEBER'S HEREDITARY ATROPHY OF THE OPTIC NERVE. HORACIO B. MOULIÉ and JUAN HURTAULT, Arch. de oftal. de Buenos Aires **10:** 677 (Sept.-Oct.) 1935.

The authors refer to the symptoms and to the usual matriarchal heredity in male members, with only occasional occurrence in the females,

as pointed out by Bell, and review the literature. They then present four cases of atrophy of the optic nerve in three males and one female in one family (another brother and sister had died in infancy), with the atrophy coming on at from 8 to 15 years of age, after an acute onset, and coming to a standstill with permanent reduction of vision and a central scotoma. Neither their parents nor their children showed any signs of the disease; the latter were, however, all under 14 years of age. The serologic and clinical data were irrelative.

C. E. FINLAY.

LAGLEYZE-VON HIPPEL'S DISEASE AND PIGMENTARY RETINITIS. ESTEBAN ADROGUÉ and JORGE MALBRÁN, Arch. de oftal. de Buenos Aires **10:** 692 (Sept.-Oct.) 1935.

This is a review of the different manifestations of retinal angiomatosis. Priority in the description of this disease the authors, with other Argentine writers, claim for Lagleyze, who described it in 1884, von Hippel not describing the disease till 1903. They reproduce Lagleyze's description of his case, in connection with which they find that the family history indicates pigmentary telangiectasia of the skin and epistaxis in a sister, one of her sons and her grandson and retinitis pigmentosa in another of her sons and in a daughter, nine other children showing no ocular lesions. Seven brothers of Lagleyze's patient and the parents of the patient showed normal eyes.

The authors review the different classifications of telangiectatic tumors made by different authorities and the published reports of cases of retinal angiomatosis in some of which there were similar lesions elsewhere. They consider the ophthalmoscopic picture described by Lagleyze and von Hippel as the most common one. The lesion may also show as numerous miliary aneurysms, as depicted by Oeller, as aneurysmic formations in the vicinity of the disk and as racemose aneurysm of the retinal vessels. They incline to consider the vascular lesion as primitive and the glial one as secondary and are supported therein by the relative benignity of similar tumors in the brain. The different points of view from a pathogenic standpoint are also reviewed.

C. E. FINLAY.

CYSTOID DEGENERATION AND CYSTS OF THE RETINA. J. CASANOVAS, Arch. de oftal. hispano-am. **36:** 239 (May) 1936.

Microscopic examination of eyes frequently reveals cystic degenerations of the retina. These are brought about by different pathologic processes but have certain features in common. In many instances the lesion is not actually cystic but edematous. Retinal cysts are considered as a terminal transformation of cystic degenerations. These are studied from an anatomicoclinical point of view.

The most frequent form of cystic degeneration is that observed in the vicinity of the ora serrata, diminishing centrally, in persons of advanced age. As age progresses the affected areas are apt to coalesce and form a ring, the width of which progresses with advancing years. The situation is too peripheric for ophthalmoscopic examination unless the retina is detached and then only with red-free light (Vogt).

Although more frequent in old persons, the cysts are also found with relative frequency in persons of 30 and even less. The earliest lesion consists in a rarefaction of the nervous elements, giving the retina a reticulated aspect; next small cavities are formed, which gradually increase in size, coalesce and invade the different retinal layers. The cystic contents consist of a serous, fibrinous and at times gelatinous fluid. Perforation of the membranae limitantes never occurs. There are great individual variations. The variations reported by different authors are reviewed in detail.

Casanovas refers to the different theories explanatory of the pathogenesis, the prevalent opinions being divisible into those according to which the primary process is atrophic and those according to which the lesion is attributable to lymphatic stasis. To the latter he inclines.

The macular region follows the retinal periphery as the most frequent site for the occurrence of cystic degeneration, its anatomic structure favoring a separation of its layers (E. Fuchs). The initial period is represented by a honeycomb aspect of the macula, observable only with red-free light, mostly in the yellow area and less frequently in the foveal or the perifoveal zones. A development of this lesion leads to cystic degeneration of the macular region. When the condition is complicated with hemorrhages extravasated blood is found in the cavities. A still further development leads to swelling of this region with a characteristic aspect and change in the direction of the skiascopic reflex (Adrogué and Senà). Large cysts can be mistaken for holes in the retina, but the differential diagnosis can be made with red-free light, which permits observation of the cyst wall.

Casanovas next refers to holes in the macula and to their formation from cysts, as maintained by different authorities.

Cystic degeneration of the macula may appear as an isolated lesion or as a development complicating other retinal pathologic processes such as retinitis pigmentosa or retinitis punctata albescens.

An anatomic examination of the lesion was carried out by Casanovas in three eyes enucleated for corneal ulcer, iridocyclitis and septic endopthalmitis in which it was localized in the external plexiform layer and produced by excessive transudation from the capillaries. E. Fuchs has also found it in glaucoma. Nuel's vesicular edema of the macula is also a cystic degeneration of the retina. Likewise in Kuhnt's central atrophic retinitis the hole formation was undoubtedly prepared by cystic degeneration.

The lack of blood vessels at the macula and at the retinal periphery, as well as their extreme thinness, explains the special vulnerability of these regions.

Cystic degeneration can also be found in other regions of the retina, with more or less diffuse distribution, having been reported in retinitis circinata, in albuminuric, diabetic and cachectic retinitis, in Coats' disease, in the Hippel, Lindau and Recklinghausen retinal complications, in tuberous cerebral sclerosis with localizations in the retina, optic nerve, chiasm and brain, and in choroidal sarcoma. In some of these conditions it may be the cause of a tear with subsequent detachment of the retina. On the other hand, in retinal detachment the substitution

of nerve tissue by glial tissue favors cystic degeneration. Casanovas reports anatomic examination of the retina in several illustrative cases.

Fully developed cysts of the retina can be congenital or acquired. The former are usually associated with malformations such as coloboma or microphthalmos. The acquired can be of parasitic origin (cysticercus) or connected with cystic degeneration. Several cases reported by different authors in connection with detachment of the retina are referred to. Most authors consider the cysts as a macroscopic development from cystic degeneration with destruction of the separating septums. Casanovas gives several detailed anatomic descriptions. C. E. FINLAY.

PRESENT STATUS OF THE TREATMENT OF RETINAL DETACHMENT. H. ARRUGA, Arch. de oftal. hispano-am. **35:** 514 (Oct.) 1935.

Arruga reviews the present status of the operative treatment of retinal detachment, which is based on the closure of the retinal tears and now yields recoveries in over 50 per cent of the cases. He insists on the necessity of a prior careful clinical study of the patient from a general and a local point of view. The percentage of cures in selected cases reaches 70, the most favorable conditions being: satisfactory general and local conditions, a traumatic origin, absence of any local reaction, and short duration. He reviews the general and local contraindications, which he tries to correct when possible without losing too much time.

He describes the preparation of the patient, the instruments, the method of anesthetization and the operative procedure. In the latter, according to the individual indications, he uses thermocautery or galvanocautery, the Vogt points, diathermy (Weve, Šafář or Lacarrère's electrodiaphake) or scleral trephining. In connection with the postoperative precautions he stresses the importance of local quiet. He reviews the possible complications.

He refers to his statistics for the period from 1932 to 1934, during which he operated on 248 patients with 168 replacements of the retina, obtaining in 141 vision over 0.15.

He concludes that by operative treatment recovery is obtained in 50 per cent of the cases, success depending on prompt execution, correct localization of the tears and their isolation by operative procedure. He considers the method employed of secondary importance but considers that diathermy offers the best chance for recovery.

C. E. FINLAY.

CURE OF DETACHMENT OF THE RETINA CAUSED BY A HOLE IN THE MACULA BY CATHOLYSIS: REPORT OF CASES. A. VOGT, Klin. Monatsbl. f. Augenh. **96:** 15 (Jan.) 1936.

Vogt discusses the advantages of his cathodal electrolysis, which he introduced in the operative therapy of detachment of the retina two years ago. One of these advantages is that bubbles of white foam aid in ophthalmoscopic localization and orientation. The value of this method in the closure of retinal tears has been proved. It is especially valuable in those cases in which a hole in the macula is the cause of a detachment of the retina. In the treatment of macular tears it is superior to chemical methods, in which the visual results are unsatis-

factory owing to the destruction of the retina. For the same reason and on account of the loss of vitreous following it, Vogt considers diathermy less reliable in these cases. He reports the case of a woman aged 26 with binocular myopia of 28 diopters and with a detachment of the retina of a spontaneous or perhaps traumatic nature. A hole in the macula the size of the diameter of a large retinal vein was closed by means of catholysis and an angular needle in two sittings, which took place seventeen days apart. The scars in the macula appeared as two faint dots, which did not interfere with the vision, the latter amounting to from 4/25 to 4/30 of the normal after correction with a concave lens of 28 diopters. This method was employed in another case in which there was a hole in the macula caused by cystoid degeneration in a woman aged 62. The vision was 1/10 of the normal before the operation and from 5/20 to 5/12 after closure of the hole, which had a diameter of about one half of a disk diameter.

K. L. Stoll.

Bilateral Detachment of the Retina with Symmetrical Tears of the Ora Serrata in Two Nonmyopic Youthful Brothers: The Doubtful Relation to Isolated Cysts of the Retina. H. Schmelzer, Klin. Monatsbl. f. Augenh. **96:** 19 (Jan.) 1936.

Two brothers aged 26 and 33 had suffered from defective vision, the younger for a few months prior to admission to the hospital, the elder for several years. These brothers resembled one another as to color of the eyes and hair, shape of the face, height and other traits common usually in "two-egg twins." A twin brother of the younger man, however, differed totally from him in appearance and had healthy eyes. The left eye of the younger patient was slightly hyperopic; the other eye and both eyes of the older patient were emmetropic. In each patient the bilateral detachment of the retina was shallow, was located in the lower portion of the eyeballs and was well defined upward. In each patient the bilateral tear at the ora serrata occurred in the temporal and lower periphery of each eye; the tears in the two patients were identical even in that the tear in one eye in each patient was subdivided by some kind of remaining trabeculae of the retina. This can be observed in the photogram of the right fundus of the younger brother and in that of the left of the elder. This appearance prompted Schmelzer to consider whether these tears might have developed on primary solitary retinal cysts such as were described recently by Weve. Etiologically, in the author's opinion, symmetrical tears of the retina are based on a developmental disturbance—probably on an abnormal "anlage" of the retina. This view appears to be supported by the anamnesis: the resemblance of these two brothers, their emmetropia and the absence of any ocular or bodily trauma. A lesion intra partum could be ruled out, as the patients were delivered without forceps.

K. L. Stoll.

Importance of the Cathode and Anode in the Electrolytic Treatment of Detachment of the Retina. A. von Szily and H. Machemer, Klin. Monatsbl. f. Augenh. **96:** 36 (Jan.) 1936.

Von Szily and Machemer discuss the results obtained with the positive and the negative pole, respectively, by Sabbadini, Imre, Vogt and

other authors in electrolytic treatment of detachment of the retina. The results of their own research on rabbits' eyes are described and illustrated with drawings and photomicrographs. No difference of importance was observed between the degrees of inflammatory action obtained with the anode and the cathode. The only practical difference rested in the type and volume of the gas produced and in the celerity of the absorption of the gas. Clinical observation showed that the formation of a large quantity of poorly absorbable gases in the vitreous and in the subretinal space may prevent reattachment of the retina. To prevent this, especially in those eyes which cannot be treated with minimal doses of the current, great care has to be taken in introducing the cathode into the vitreous chamber. The anode deserves the preference because it gives rise to less gas and at the same time produces an equal amount of inflammation. The cathodal needle is not always useful in placing punctures because the retinal focus can be observed less readily around the cathode and the bubbles of gas may change their location where liquefied vitreous is present. The cathode, however, may be attached to the perforating needle when the white focus of the anode cannot be observed in consequence of gray retinal reflexes.

K. L. STOLL.

LYSOTHERAPY FOR RETINITIS PIGMENTOSA. N. K. MANYUKOVA, Sovet. vestnik oftal. **8:** 349, 1936.

Manyukova applied lysotherapy in forty-three patients who suffered from retinitis pigmentosa. The lysates were made of retina, liver, anterior and posterior hypophyseal lobes, corpus luteum and adrenal cortex. In twenty-four patients the Lüttge-Mertz reaction showed dysfunction of the adrenal cortex, of the posterior lobe of the pituitary gland and of the liver. From fifteen to twenty-five subcutaneous injections of the polylysates were given at the rate of one every third day, the dose being from 0.2 to 0.3 Gm. of each lysate. There was neither objective nor subjective improvement in seven patients. Eleven patients noted a decrease of hemeralopia. In twenty-five patients (58 per cent) the visual acuity and the dark adaptation were improved, and the visual fields were enlarged 5, 10 and 15 degrees in all directions. These effects, however, were transitory, lasting for about two or three months; repeated injections were given to the majority of the patients in the last group.

The conclusions are as follows: The improvement in the visual acuity and the dark adaptation and the enlargement of the visual fields in 58 per cent of the forty-three patients treated make polylysates desirable therapeutic agents in the management of retinitis pigmentosa. The effect of the therapy is transitory. The results in atypical forms of retinitis pigmentosa are more stable.

O. SITCHEVSKA.

Trachoma

THE CARBOHYDRATE MATRIX OF THE EPITHELIAL-CELL INCLUSION IN TRACHOMA. C. E. RICE, Am. J. Ophth. **19:** 1 (Jan.) 1936.

This study represents an attempt to determine microchemically the nature of the von Prowazek-Halberstaedter inclusion body regardless of

whether it is specifically concerned in trachoma or not. The work is based on observations on seventeen cases of active trachoma at the United States Trachoma Hospital, Rolla, Mo. The following conclusions are given:

"1. The v. Prowazek-Halberstaedter inclusion body in the epithelial cells of trachomatous conjunctivae contains a very appreciable amount of carbohydrate which gives a sharp color reaction with iodine. The evidence seems to indicate that this carbohydrate in the trachoma inclusion body is glycogen. This carbohydrate evidently exists in part as a matrix or diffused throughout the inclusion.

"2. The v. Prowazek-Halberstaedter inclusions may, therefore, be demonstrated with a modified Lugol's solution.

"3. With the weak Lugol's solution, the v. Prowazek-Halberstaedter inclusions can be more certainly demonstrated in thick and indifferent smears than with the use of Giemsa stain. For the clinician, this iodine stain should prove a quick and simple method of examining conjunctival scrapings for inclusions.

"4. It can be demonstrated that the v. Prowazek-Halberstaedter inclusions in wet preparations of unfixed cells contain varying numbers of easily visible granules, after removal of the carbohydrate matrix. These granules are in all probability the 'elementary bodies' of von Prowazek and the so-called 'initial bodies' of Lindner."

W. S. REESE.

STUDIES ON THE INFECTIVITY OF TRACHOMA. R. W. HARRISON and L. A. JULIANELLE, Am. J. Ophth. **19:** 118 (Feb.) 1936.

Harrison and Julianelle give the following summary and conclusions:

"1. A study has been made of the bacteria cultivable from trachoma and clinically similar diseases as well as from normal eyes.

"2. The bacteria cultivable from trachoma are not typical of that infection since they are also recoverable in approximately similar frequency for other conditions of the eye.

"3. While less numerous, the same bacteria may be isolated from the eyes of normal individuals.

"4. The bacterial flora of trachoma does not vary with the different clinical stages of the disease nor with the presence of epithelial-cell inclusions.

"5. Inoculation into susceptible monkeys of all the different varieties of cultures isolated, either individually or pooled, does not induce experimental trachoma even though the tissues from which the bacteria are derived are demonstrably infectious.

"6. Filtrates of infectious trachomatous material when inoculated simultaneously with the organisms isolated exhibit no supplementary nor associated activity capable of rendering the organisms specifically infectious.

"7. The observations made in the present study furnish no evidence, therefore, that any of the bacteria cultivable from trachoma induce the experimental disease in monkeys."

W. S. REESE.

THE SO-CALLED FOLLICLES IN THE SECOND STAGE OF TRACHOMA. R. J. PULVERTAFT, Rev. internat. du trachome **13:** 19 (Jan.) 1936.

In stage 1 of trachoma the subepithelial tissue is densely infiltrated by lymphocytes and some plasma cells. These are frequently organized in oval units with central endothelial cell areas. Nothing can be expressed from these solid follicles. In stage 2, the subepithelial infiltration gives way to dense fibrous tissue, and the ducts of the meibomian glands, obstructed in the process, produce bleblike excrescences. These are the "follicles" which are expressible; they are analogous to the cystic changes in acne and rhinophyma.

J. E. LEBENSOHN.

DIAGNOSIS OF RUDIMENTARY PANNUS. A. TRUBIN, Rev. internat. du trachome **13:** 34 (Jan.) 1936.

Trachoma is essentially a keratoconjunctivitis, and pannus in one form or another is invariably present. For the rapid diagnosis of incipient pannus Trubin suggests examination with a plane mirror ophthalmoscope through a lens of from 10 to 15 diopters. The transmitted light reveals black stripes in the early corneal lesion, corresponding to vessels filled with blood. These stripes become progressively more transparent as the lesion cicatrizes and the vessels empty.

J. E. LEBENSOHN.

Tumors

TUMOR OF THE POSTERIOR POLE ENDURING FOR SEVEN YEARS. P. VEIL, Bull. Soc. d'opht. de Paris, April 1936, p. 302.

Veil completes his observations of a patient whose case was reported to the society in June 1929, June 1930 and March 1933. The interest in the case is due to its long duration and to the fact that the original diagnosis of angioma of the choroid has been confirmed by anatomic findings. The patient, first seen at the age of 50, in 1929, stated at that time that he had had herpes of the left eye complicated by keratitis and paralytic mydriasis in 1926. In 1928 some difficulty in the visual acuity of the right eye resulted in discovery of a central scotoma. Later, vision was reduced to 0.3, with a central scotoma for colors. A small pigmented lesion was found in the macular area, while the inferior and internal portion of the disk had a gray, edematous appearance and dilated veins which showed considerable parallactic displacement. Treatment with mercuric cyanide, neoarsphenamine and iodized poppy-seed oil 40 per cent did not help. The progress was very similar to that in von Hippel's patient (*Arch. f. Ophth.* **127:** 27, 1931). However, the tumor appeared somewhat like a small round cell sarcoma, as noted in the illustrations. Veil believes that von Hippel's triad of slow evolution, peripapillar extension and macular alterations does not permit the diagnosis of angioma.

L. L. MAYER.

LYMPHOMA OF THE CONJUNCTIVA. F. TERRIEN, Bull. Soc. d'opht. de Paris, April 1936, p. 307.

Lymphomatous tumors of the conjunctiva are very rare. Terrien presented a patient at the last meeting whose lesion proved to be a

lymphoma. The tumor was slightly adherent to the subconjunctival tissue and consisted of a mass of round cells, irregularly flattened, with large nuclei and little protoplasm—thus having the appearance of lymphocytes. Few vessels and little conjunctival tissue were found in the interior of the mass. Around the tumor were dilated, sanguineous capillaries. The observations of Koerber and Cosmettatos (*Ann. d'ocul.* **137**: 288 [April] 1907) were entirely comparable, with the difference that Terrien's patient was a man of 60 years while their patients were young adults.

L. L. MAYER.

Uvea

FOREIGN BODIES LIKE "GOLD NUGGETS" ON THE IRIS. R. ROSSANO, Bull. Soc. d'opht. de Paris, December 1935, p. 759.

A patient aged 40 complained of poor visual acuity, which he attributed to the fact that he had a war bullet in his left temporal region. The roentgenogram showed two opaque spots, one in the left orbit near the external parotid gland and the other in the frontal sinus of the left side. The visual acuity of the right eye was 0.3; that of the left, 0.2. The fundi were normal. Examination of the left eye with the slit lamp revealed on the iris, in the inferior temporal sector, near the pupillary border, a number of small brilliant points resembling small nuggets of gold. The cornea was scarred only very slightly. The right eye was normal. Rossano questions that this material is cholesterol because of the absence of siderosis and chalcosis. May it not be silicon?

L. L. MAYER.

FEBRIS UVEOPAROTIDEA (HEERFORDT). A. D. NOWKIRISCHKY, Klin. Monatsbl. f. Augenh. **95**: 620 (Nov.) 1935.

Heerfordt in 1909 described a syndrome of inflammation of the uvea and parotid gland. The course was subchronic, with persistent low fever, swelling of the parotid gland, stubborn uveitis and frequent paresis of cerebrospinal nerves.

Nowkirischky reports a similar condition in a boy aged 17 in whose family tuberculosis was absent. Both eyes became inflamed consecutively, showing stippled keratitis and iritis with posterior synechiae. Nodules resembling proliferating tuberculous nodules developed in the stroma of the iris near the pupillary margin; there were also round exudative nodules in the same location. The vitreous was cloudy. The parotid glands were swollen and the lacrimal glands enlarged. The roentgenogram showed dense shadows at the hilus and veiling of the lungs suggesting tuberculosis, the presence of which, however, remained uncertain. The condition of the eyes persisted during the hospitalization of the patient from April 16 to May 28, 1934.

Repeated treatments at the hospital and observation for seventeen months failed to establish distinctly whether there was pulmonary tuberculosis, although a tuberculous diathesis was evident and miliary tuberculosis was suspected when the roentgenogram of the right lower lobe of the lung showed small dotted shadows for a certain period.

This patient presenting a number of symptoms suggesting the tuberculous etiology of Heerfordt's disease showed that the disease may be associated with persistent grave ocular symptoms. K. L. STOLL.

Vitreous

CLINICAL STUDIES ON THE VITREOUS: I. THE CONTRACTION OF THE VITREOUS. K. LINDNER, Arch. f. Ophth. **135:** 332 (May) 1936.

In 1930 before the German Ophthalmological Society Lindner first expressed a theory concerning the part played by the vitreous after a retinal tear has been formed. The involved eye is always at least relatively hypotonic because, according to Leber, the intra-ocular fluids find a new outlet in the exposed choroid. This increased outflow, according to Lindner, calls for increased formation of fluid by the ciliary body. This fluid has the characteristics of regenerated, or second, aqueous and is assumed by Lindner to cause contraction of the vitreous. To prove this experimentally, Lindner performed on young rabbits what he calls a "vitreous-fistula operation." He exposed the sclera in the region of the equator, treated an area from 2 to 4 mm. in diameter after the method of Larsson, with nonperforating electrocoagulation, and trephined the sclera, choroid and retina with a 2 mm. trephine. The effects of the operation were a deepening of the anterior chamber, chemosis, edema of the lids and hypotony of the globe. All these changes started about three hours after the operation, reached their height after another three hours and persisted for about one week. Anatomically, the picture was that of acute hypotony in man, viz., a transudate filling the chambers, hyperemia of the uvea, an excessively deep anterior chamber and a partial or total serous retinal detachment.

Lindner interprets this picture as follows: After the trephining the intra-ocular pressure drops to zero. A rapid formation of aqueous rich in proteins sets in. This equeous trickles through the vitreous toward the trephine hole and though the latter into the subconjunctival space. Under the influence of this regenerated aqueous a strong active contraction of the vitreous sets in, the retina and choroid become detached, and the lens is pulled backward.

The obvious objection to this interpretation is that the fistulation alone produces all the aforementioned changes and that there is no important change going on in the vitreous. To this Lindner replies that repetition of the operation on the same eye often fails to produce acute hypotony although at the operation a large amount of intra-ocular fluid escapes.

This operation performed on human glaucomatous eyes produced, as a rule, no acute hypotony—probably, according to Lindner, because the regenerated aqueous of human eyes is not rich in proteins. If, however, the operation was combined with subconjunctival injection of a 10 per cent solution of sodium chloride, it produced acute hypotony with choroidal detachment lasting a week. No permanent reduction of tension could be accomplished.

The spontaneous acute hypotony that occurs without apparent provocation in heretofore quiet eyes with retinal detachment Lindner explains

as caused by an iritis which suddenly increases the protein in the aqueous. The increased amount of protein makes the aqueous more capable of causing shrinking of the vitreous.

The contraction of the vitreous is discussed in the light of the recent article entitled "Structure of the Vitreous" by Friedenwald and Stiehler (*Arch. f. Ophth.* **14:** 789 [Nov.] 1935). Lindner's view of the contraction of the vitreous under the influence of regenerated aqueous can serve as a guide in the solution of clinical problems. For instance, in the treatment of retinal detachment it does not seem advisable, after the subretinal space has been emptied, to have a fistula form in the eye operated on. In detachment in an aphakic eye the regenerated aqueous can do more damage to the vitreous because of their proximity. Any lowering of the tension (by puncture of the anterior chamber or by iridectomy) makes the vitreous shrink temporarily. The tension-reducing effect of any inflammatory process (Hamburger) may be partly due to contraction of the vitreous.

P. C. KRONFELD.

Therapeutics

COD LIVER OIL AS LOCAL TREATMENT FOR EXTERNAL AFFECTIONS OF THE EYES. E. STEVENSON, Brit. J. Ophth. **20:** 416 (July) 1936.

In support of his conclusions, the chief of which is that cod liver oil has undoubted and rather surprising efficacy as a healing agent, Stevenson cites several cases, including cases of burns of the lids and eyeball and of the cornea, dendritic ulcer and relapsing keratitis, in which this agent was used with success. The notes on 150 patients treated at the clinic indicate that its use has greatly reduced the "pre-oil" number of necessary attendances. Its use should be withheld in the early stages of hypopyon keratitis. Cod liver oil applied locally seems to promote the growth of natural tissues and to inhibit the growth of scar tissue in any case in which there is loss of substance.

W. ZENTMAYER.

THERAPEUTIC EXPERIENCES WITH INHALATIONS OF AMYL NITRITE IN DISEASES OF THE FUNDUS. E. BIRÓ, Klin. Monatsbl. f. Augenh. **96:** 649 (May) 1936.

Biró reports on the experiments made with inhalations of amyl nitrite at E. von Grósz' ophthalmologic clinic at Peter-Pázmány University in Budapest during the last four years. The results of the treatment of divers ocular diseases are rubricated on a number of tables.

Vision was improved in 46 per cent of fifty-seven patients with chiefly chronic fundus changes. The improvement occurred mainly in hypertonic (nephritic) retinitis, choroiditis of nonsyphilitic origin, chorioretinitis, and recent and partial central embolism of the retina as well as in the dominantly hereditary type of pigmentary degeneration of the retina. No effect was recorded in locomotor atrophy of the optic nerve.

Small doses of amyl nitrite, limited to two or three inhalations, are free from risk if applied before meals under certain precautions. The

vascular system is examined with the tonoscillograph after the method of Plesch. The inhalations are not used in patients with brittle blood vessels in which the tonoscillograph shows wide excursions. It was observed that hemorrhages occurred in patients with hypertension of about 200 mm. of mercury as well as in some with normal blood pressure but wide excursions of the apparatus. The observation showed, in Biró's opinion, that hemorrhages are less the result of hypertension than of diseased blood vessels.

K. L. STOLL.

Society Transactions

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

March 19, 1936

CHARLES R. HEED, M.D., *Chairman*

A. G. FEWELL, M.D., *Clerk*

PRESENTATION OF THREE CLINICAL CASES. DR. WARREN S. REESE.

(*a*) *Syphilitic Optic Neuritis.*—A colored girl aged 16 stated that three weeks ago frontal headache developed and she noticed that she was losing vision of the left eye. Three days ago the right eye became red and painful. Vision in the right eye was 6/9, and in the left, perception of movements of the hand. External examination revealed episcleritis of the upper outer quadrant of the right eye and a pupil that did not react to light on the left side. The left fundus showed a markedly choked disk, and the swelling measured from 5 to 7 diopters. The macular region presented an incomplete star-shaped figure, while the periphery of the fundus was normal. Physical examination gave negative results except for chronic tonsillitis and adenoiditis. The Wassermann test of the blood and of the spinal fluid was negative. A second and a third Wassermann test of the blood were positive to the extent of four plus. The papilledema gradually subsided under antisyphilitic treatment, and on March 12 numerous fine vitreous opacities appeared in the left eye. The pains in the head, which were most severe at night, diminished, and vision began to improve.

(*b*) *Dermoid Cyst of the Globe.*—In the left eye of a girl, just beyond the outer limbus, was a growth that resembled a typical dermoid, except that it had no hair growing from it. The irregular and rather extensive cystic growth involving the upper nasal quadrant of the same eye appeared to be an unusual type of dermoid.

(*c*) *Pituitary Tumor.*—A woman aged 44 complained of a growth on the right eye which had been present for the past five weeks. Vision of both eyes was 6/60; it was improved to 6/9 in the right eye and to 6/12 in the left with a plus 3.25 diopter sphere. External examination gave negative results except for a pear-shaped cystlike elevation at the inner limbus of the right eye, measuring about 4.5 mm. in length and 2 mm. in width. Slit lamp examination gave negative results. Ophthalmoscopic examination revealed a condition which was thought to be pseudoneuritis, both disks being slightly elevated and their margins obliterated. The vessels showed no abnormalities. Perimetric examination gave negative results except for a markedly enlarged blindspot, especially in the left eye. Neurologic examination disclosed a rather marked metabolic disorder of the hypopituitary and hypo-ovarian type but no definite evidence of organic nervous disease. A roentgenogram showed erosion of the sella turcica, indicating an intrasellar growth.

DISCUSSION

DR. WILLIAM ZENTMAYER: The ophthalmoscopic appearance in the third case resembles that in pseudopapilledema, but the diagnosis cannot be based on this alone. The absence of both engorgement and enlargement of the retinal veins and the facts that the fields show no changes except enlargement of the blindspot and that papilledema is rare in cases of pituitary tumor leave the diagnosis open. I think that a correct diagnosis cannot be made unless the patient is followed up.

A CASE OF SYMPATHETIC OPHTHALMIA WITH SUBSTANTIAL RECOVERY OF VISION. DR. C. E. SHANNON.

G. H. P., a man aged 34, visited my office in October 1935, complaining of pain and tenderness in the left eye, associated with marked depreciation of vision. The history, which is somewhat fragmentary, is as follows:

In July 1935, while he was opening a box, his right eye was struck by a nail, which produced a penetrating wound of the cornea at 5 o'clock, with prolapse of the iris, and laceration of the crystalline lens. The patient was immediately sent to the hospital and given an injection of antitetanus serum and appropriate local treatment. Three days later the prolapsed iris was excised; the lens was extracted by the linear method, and a conjunctival flap placed. As a precautionary measure daily injections of 5 cc. of milk and large doses of sodium salicylate were given. Four weeks after the accident there was no evidence of sympathetic irritation or inflammation, although the injured eye was still slightly congested, and the patient was discharged. The Wassermann and Kahn tests were negative.

The patient was readmitted to the hospital about ten weeks after the initial injury, with a history of lacrimation and diminution of vision of the sympathizing eye, which had developed a week prior to readmission and approximately nine weeks from the date of injury. The exciting right eye was painful and congested and was enucleated at once. Unfortunately, no microscopic study of the eyeball was made. Four and a half weeks after the enucleation examination revealed a quiet right socket and a left eye moderately congested, which was tender on pressure. The left eye had vision of fingers at 7 feet (213.4 cm.). Slit lamp study demonstrated infiltration throughout the substantia propria, and precipitates on the posterior surface with many linear markings resembling folds in Descemet's membrane, and the iris showed many posterior synechiae, while numerous deposits of pigment were noted on the anterior capsule of the lens. The transilluminating beam of light was slightly relucent from the aqueous, and the pupil was irregular and moderately dilated. No details of the fundus were obtainable on account of the corneal infiltration and, probably, opacities of the vitreous. The tension, taken with the fingers, was apparently normal.

The patient was immediately sent to the hospital for active treatment, which consisted of the following measures: intravenous injections of typhoid vaccine every other day, beginning with a dose of 0.1 cc., representing 100,000,000 germs, which was gradually increased to 0.3 cc.; mercurial inunctions twice daily, and, as local measures, treatment with atropine, ethylmorphine hydrochloride and hot compresses. The reactions from the typhoid vaccine were satisfactory, the temperature

reaching approximately 102 F. after each injection. After the third injection the eye began to quiet down, and vision showed definite signs of improvement. The treatment was continued until the patient had received ten injections of typhoid vaccine. After three weeks of treatment the left eye showed vision of 6/6. The slit lamp showed that the infiltration of the cornea had almost entirely disappeared, but the deposits of pigment on the anterior capsule were unchanged. With the ophthalmoscope it was noted that the vitreous opacities had in a great measure been absorbed, and the details of the fundus were fairly clear, with no gross lesions.

DISCUSSION

DR. GEORGE DE SCHWEINITZ: I have in mind the case of a woman who had fully developed sympathetic ophthalmia, the result of a neglected laceration of the eye. She was sent to the Hospital of the University of Pennsylvania, where she received the treatment which was customary at this period, a number of years ago, and ultimately obtained a complete cure, but not until a low grade nephritis had yielded to treatment. I believe that it is essential in all cases of sympathetic ophthalmia to make a thorough general examination and to eliminate any general disease factor that might be discovered.

DR. H. MAXWELL LANGDON: Concerning the enucleation of the exciting eye, I think that a great deal of care should be taken before this is done. If the eye is blind it should be removed, as this may possibly do some good even if the sympathetic attack has started. If, however, the eye has vision which is at all useful it probably should not be removed, as after the sympathetic attack it may be the better eye of the two. This, of course, does not apply to eyes which may cause sympathetic disease before such an attack has started. In such cases removal is definitely indicated.

DR. J. MILTON GRISCOM: Dr. Jonas S. Friedenwald made the suggestion that exposure of the bodies of patients suffering from sympathetic ophthalmia to ultraviolet rays might result in stimulation of pigment in a locality distant from the eye, thus supplying an antigen which would combine with the antibodies. He has treated three patients by this method, with favorable results.

ANGIOID STREAKS OF THE RETINA ASSOCIATED WITH PSEUDOXANTHOMA ELASTICUM AND DISCIFORM MACULAR DEGENERATION. DR. EDMUND B. SPAETH and DR. JOSEPH I. GOUTERMAN.

After a brief outline of the highlights of angioid streaks and pseudoxanthoma elasticum, a typical case is described. The patient was a colored woman 58 years of age. The characteristic ocular lesions consisted of bilateral circumpapillary rings (complete in the left eye and incomplete in the right eye), radiating angioid streaks on a slate-gray peripapillary zone, extensive retinal hemorrhages in various stages of absorption and bilateral disciform macular exudation. The clinical dermatologic lesions were pathognomonic of pseudoxanthoma elasticum, and a biopsy of skin clinched the diagnosis.

DISCUSSION

DR. SIGMUND S. GREENBAUM: Pseudoxanthoma elasticum is in no way, so far as is known, related to xanthoma. The latter condition is

an infiltrative process, particularly in the skin, in which it produces tumors, the result of degeneration of fat. There are about 16 reported instances of associated angioid streaks of the retina and pseudoxanthoma elasticum. This represents about 25 per cent of the reported instances of pseudoxanthoma elasticum, and one would infer that the two conditions may in some way be related. The cutaneous histologic features are perfectly clear: There is elastic degeneration in the dermic structures, and it may be that this represents a presenile change, since the same histologic picture is present in senile degeneration of the skin. In the past twenty years I have seen 3 instances of pseudoxanthoma elasticum: the first while I was a student in Paris and the second about nine years ago: the present case represents the third. In the first two cases no examination was made for angioid streaks, since the association was noted only some six or seven years ago. The present case is the second one in which the diagnosis of pseudoxanthoma elasticum followed the discovery of the presence of angioid streaks.

DR. WILLIAM ZENTMAYER: The patient, the fundus of whose eye was shown on the screen, was under my observation for twenty-five years. The last time that he was seen was in 1934, when he was reexamined at the request of Dr. Terry for evidence of osteitis deformans. He was thoroughly studied by Dr. Arnett, and roentgenograms of the skeleton were taken, but there was no evidence of Paget's disease.

The case reported by Dr. Spaeth and Dr. Gouterman is of special interest because of the association of the streaks with disciform macular degeneration. Batten has called attention to the frequency with which circinate retinitis, which is allied to disciform macular degeneration, is found in association with angioid streaks.

The subsequent history of Verhoeff's patient, as given by Dr. Terry, is that the halo about the papilla is more prominent, and black streaks are now noticeable. This, of course, would strengthen Verhoeff's assumption that the opposite eye, of which he made a histologic study, was the seat of angioid streaks.

In view of the facts that up to 1934 but 9 cases of angioid streaks in association with Paget's disease had been reported, that the examination of 22 patients with Paget's disease showed angioid streaks in 3, and that 23 cases of pseudoxanthoma elasticum with associated angioid streaks have been reported, I think that unless the two general conditions have a common pathogenesis there must be some underlying common cause for the cutaneous condition and the ocular condition.

April 16, 1936

CHARLES R. HEED, M.D., *Chairman*

A. G. FEWELL, M.D., *Clerk*

MARGINAL DEGENERATION OF THE CORNEA WITH PROLAPSE OF THE IRIS. DR. WILLIAM ZENTMAYER.

Dr. Zentmayer reviewed the recent literature on marginal degeneration of the cornea and discussed the clinical aspects, including the biomicroscopic findings and the histologic features of this condition. He

called attention to the fact that there are but few cases reported in the American literature and that in all the cases reported there were only 7 with prolapse of the iris as a complication.

On Oct. 21, 1935, Mrs. C. F., aged 52, was referred to Dr. Zentmayer by Dr. M. E. Smukler. The patient was born in Russia and came to America fourteen years before. There was a history of inflamed eyes during childhood. In 1930 she was under treatment for hyperthyroidism, and the same year Dr. Smukler did a multiple ignipuncture on the lower lid of the left eye for entropion and trichiasis. At about the time that Dr. Smukler first saw the patient she had consulted a druggist because of a foreign body in the right eye, and in removing it he noted the prolapse of the iris. In both eyes there was marginal dystrophy of the entire circumference of the cornea. The resulting furrow was of uneven depth. In the right eye there was a prolapse of the iris about 3 mm. in diameter through the floor of the furrow. The protruding iris tissue was covered by the epithelium. The sensibility of the cornea was subnormal. The epithelium was intact, as was evidenced by the absence of staining with fluorescein. The tension of the right eye was 22 mm. of mercury, and that of the left, 20 mm. A 1 per cent solution of physostigmine salicylate was instilled into the eye, with little or no effect on the size of the prolapse.

Biomicroscopic examination revealed that, as the corneal image of the light was swept across the limbus, it became constricted over the grooved portion. The constriction was particularly marked at the upper margin, where a deep groove was apparent, reaching well into the substantia propria. The epithelium was intact. The limbic vascular loops extended farther into the cornea than normally. It was impossible to determine whether the endothelium was intact in the involved portion of the cornea, but it was normal in the surrounding area. No folds were visible in Descemet's membrane. There were disseminated areas of thinning of the uveal pigment in the zone of the sphincter. The lens was normal.

DISCUSSION

DR. ALFRED COWAN: The slit lamp picture of the type of marginal dystrophy shown here by Dr. Zentmayer corresponds to the microscopic findings, as it seems that the condition is due to a loss of cornea proper, leaving both the epithelial and the endothelial surfaces intact, so that there is a gutter-like depression of the anterior surface, while the posterior surface remains intact. At the portion where the iris is prolapsed it is hard to tell with the slit lamp whether one is dealing with an epithelialized surface of the iris or whether the iris is covered with intact Descemet's membrane; but it seems that it is the surface of the iris and not Descemet's membrane which is seen over the hernia. It is easy to see in an ordinary descemetocele that the cornea is lost down to Descemet's membrane, but in this case, since the corneal propria is absent in the neighborhood of the ectasia, the anterior and posterior surfaces of the cornea become narrower toward the edge of the prolapsed iris. In those cases of corneal abscess in which the entire cornea sloughs off, leaving the bare iris, the surface of the iris becomes epithelialized in a short time and resembles the condition under discussion. However, in 2 cases mentioned by Koby, one of his own

and one of Trantas, in each of which there was an ectasia of the cornea, Descemet's membrane, from the description, seemed to remain intact in one and be perforated in the other.

COMPLETE REATTACHMENT OF THE RETINA FOLLOWING OPERATION WITH THE THERMOPHORE. DR. ANDREW KNOX (by invitation of Dr. H. Maxwell Langdon).

W. L., aged 52, entered the Hospital of the Protestant Episcopal Church on Jan. 27, 1936, complaining of marked depreciation of vision in the right eye of one week's duration. Examination with the ophthalmoscope revealed a number of small dark opacities located in the vitreous. There was a large detachment of the retina extending from 9 to 2 o'clock, with a marked dip in the center. Transillumination showed no abnormality. Vision was movements of the fingers above the point of fixation. There was complete loss of the visual field. The left eye was normal externally and intra-ocularly, with vision of 6/6.

The patient was admitted to the hospital and placed on his back, sand-bags being placed on each side of his head. Atropine was instilled into each eye, and pinpoint goggles were ordered. On the day after admission to the hospital the patient stated that he thought that his his vision had improved slightly. On February 3 the detachment showed improvement, and there was some increase in the size of the field. On February 4 the patient was operated on by Dr. Langdon. The following operative procedure was carried out: After the eye was prepared in the usual manner, 3 drops of a 4 per cent solution of cocaine hydrochloride was instilled at three minute intervals. A retrobulbar injection of a 2 per cent solution of procaine hydrochloride was also given. The bulbar conjunctiva was dissected freely, well beyond the area of the detachment. The sclera was then pierced on either side of the superior rectus muscle with a von Graefe knife, thus allowing the subretinal fluid to exude. The thermophore was then applied seven times at different points on the sclera corresponding to the area of detachment. The thermophore at the temperature of 168 F. was applied to the sclera for one minute at each application. The conjunctiva was replaced and sutured, and the patient was returned to the ward. After forty-eight hours the eye was dressed and carefully examined. There was a small amount of edema of the lids and conjunctiva. Examination with the ophthalmoscope showed the retina to be completely reattached. The fields were roughly taken and seemed to be full. The patient was confined to bed for three weeks after the operation. The fields were again taken at the end of this time and showed practically a complete recovery. Vision was 20/40 with correction.

DISCUSSION

DR. H. MAXWELL LANGDON: This procedure is simple. One great advantage is that it does not disturb the eye, and if one does not get good results it is possible to go ahead with whatever operation one may wish. That this particular type of operation works has been proved, I think, by the 3 cases I have presented here: in one the operation was done in September 1934; in the second, last November, and in the third, in February. The patient who was operated on in September

1934 has still the same field and the same central vision, and there is no change whatsoever. The patient who was operated on in November has a full field, with vision of 5/22. The retina was detached four months before I saw her. If the patient had been seen earlier I think that better vision would have resulted. The operation is one, I believe, that any one could do, and I hope that some one will try it and see how it works in a series of cases other than the type my associates and I have observed.

TUBERCULIN TESTS IN OPHTHALMOLOGIC CASES. DR. GEORGE P. MEYER (by invitation of Dr. Francis H. Adler).

In the study of ocular tuberculosis a properly performed intracutaneous tuberculin or Mantoux test is of great assistance. It is important to observe certain precautions in the technic in performing the test and to use a potent old tuberculin or, preferably, the purified protein derivative. The latter product has the advantage of being stable and uniformly potent in its commercial tablet form. A positive Mantoux test indicates a previous tuberculous infection. It indicates that the patient is hypersensitive. It does not indicate presence or lack of activity in the lesion. The degree of hypersensitivity does not parallel the degree of immunity. A study is being made to determine whether patients with ocular tuberculosis manifest a higher degree of sensitivity than nontuberculous persons.

INTERPRETATION OF CASES OF UVEAL TUBERCULOSIS AND EXPERIMENTAL TUBERCULOUS ALLERGY. DR. FRANCIS H. ADLER.

This paper will be published in full in a later issue of the ARCHIVES.

HISTOPATHOLOGY OF EXPERIMENTAL TUBERCULOUS ALLERGY OF THE CHOROID. DR. ESMOND R. LONG (by invitation of Dr. Francis H. Adler).

Previous experiments have shown that the cornea in tuberculous guinea-pigs is exquisitely sensitive to tuberculin. In the experiments reported at this time the effects of the instillation of tuberculin into the uveal tract were studied. The purified protein derivative of tuberculin was used. Up to the present in these experiments efforts have been largely directed toward determining minimal doses effective in producing allergic reactions in the choroid. A dose of 0.000005 mg. of the purified protein derivative proved too small to produce cellular inflammatory reactions visible at the end of four days, although a cellular protein exudate between the choroid coat and the retina, which was not present in the control animals, followed the introduction of this dose in sensitive guinea-pigs in a number of cases. Somewhat higher doses were likewise ineffective in producing the well known type of cellular inflammation occurring in the skin and cornea of tuberculous guinea-pigs on suitable injection. On the other hand, an intense cellular inflammation of the choroid followed the subscleral injection of 0.01 mg. of the purified protein derivative into tuberculin-sensitive guinea-pigs. Three days after injection the choroid was distended to five times the normal thickness as a result of infiltration by polymorphonuclear leuko-

cytes and monocytes. Evidence from other experiments suggests that the initial infiltration was with the polymorphonuclear leukocytes and that rapid replacement by the monocytes was occurring by the third day. In an effort to simulate tuberculosis of the choroid without the use of tubercle bacilli, experiments are in progress in which purified phosphatide from the tubercle bacillus, with or without the purified protein derivative of tuberculin, is instilled subsclerally. Definite tubercle-like nodules, tending to be absorbed in sixteen days, have been produced by this method in a number of experiments.

DISCUSSION

DR. H. MAXWELL LANGDON: There are two or three things of great interest in this splendid presentation. One is the number of negative responses which Dr. Meyer reported in the investigation carried out by his colleagues and himself. As he said, the ophthalmologist is surprised when he has a negative report, because he is led to believe that tuberculous infection is widespread. I should like to ask Dr. Long whether he thinks that over a long period there would be a great variation of sensitivity. Of course, I know that sensitivity would not vary in a few weeks or a month, but would it vary in about five or eight years?

The picture which Dr. Adler showed of a macular lesion from Dr. Wilmer's atlas has been of interest to me because I have a patient with an identical condition at present. The only demonstrable source of infection was two badly infected teeth on the side of the affected eye.

DR. ESMOND R. LONG: The conditions modifying the intensity of the tuberculin reaction are not all known. In the course of a long period the level of sensitivity may change for several reasons. The most intense reactions seem to occur in healthy persons in close and continued contact with open tuberculosis, that is, in persons who are resisting repeated infection. Hence changes in the intensity of the exposure may modify the intensity of the sensitivity. Altogether apart from this, irregular seasonal variations in the strength of the tuberculin reaction have been observed when the same person is tested at intervals for a year or more. Certain changes occur regularly in patients with tuberculosis. It may be added that standard tuberculin of constant strength is a necessity in determining these variations in sensitivity.

DR. FRANCIS H. ADLER: Dr. Langdon's interesting observation confirms the fact that these tuberculous allergic lesions have nothing characteristic about them. They do not differ in any respect from other acute inflammatory lesions of the choroid. This also serves to prove the point that one can never deduce the cause of a lesion in the eye from the fact that it disappears when some focus of infection is removed, as these allergic lesions clear up rapidly of themselves.

ZONULAR OPACITY OF THE CORNEA. DR. WILLIAM J. HARRISON.

A man aged 58, a hatter, was exposed daily to the influence of flying fur, hair and mercury vapor, in the close confines of a room, for a working period of thirteen years. The opacity embraced an area in each cornea from 1 to 2 mm. from the limbus on each side and 6 mm.

from the limbus below and just slightly bove the midline. The calcareous infiltration seemed for the most part to be in Bowman's membra· e, extending at different parts into the substantia propria but never a.. deeply as Descemet's membrane. The tension was 29 mm. of mercury in each eye. Vision corrected was 20/20 in the right eye and ·/30 in the left. Full campimetric and perimetric fields without ·tomas were obtained. The blindspots and the fundi were normal.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

Hanover, N. H., May 23, 1936

JAMES J. REGAN, M.D., *President*

WILLIAM P. BEETHAM, M.D., *Secretary*

INFLUENCE OF SIZE DIFFERENCES OF THE OCULAR IMAGES ON THE HOROPTER. DR. W. HERSAU.

The following types of differences in size are discussed: (1) physiologic differences correlated with asymmetrical convergence, (2) artificial differences induced by glasses of different magnifications and (3) the pathologic differences that occur in aniseikonia. The separate influence of the first and of the second type on the horopter was investigated (a special study having been made in Tschermak's laboratory), and it was found that while the rotation of the frontal plane horopter effected with magnifying lenses was following absolutely the computed amount, the rotation induced by the physiologic difference in size in asymmetrical convergence was much less than was mathematically expected. This indicated that a compensation takes place with asymmetrical convergence. This compensation would tend to meet the argument which is based on a well known fact, that rather large differences in size between the ocular images accompany asymmetrical convergence and yet, apparently, cause little or no ocular trouble. This has been cited against the importance of differences in size in general (von Hess, von Rohr and Erggelet) and against aniseikonia in particular (Jackson and Ludvigh).

CHANGES IN THE RELATIVE SIZE OF THE OCULAR IMAGES WITH ASYMMETRICAL CONVERGENCE. DR. KENNETH OGLE.

Evidence is presented from several types of experiments on the haploscope which establishes the existence of some type of mechanism that compensates for the differences in the size of the retinal images introduced when one looks to the right or to the left at near visual distances—for example, in reading. These experiments showed nearly complete compensation in the vertical meridian and partial compensation in the horizontal meridian. These results tend to explain the fact that the differences in size introduced by asymmetrical convergence do not interfere with reading.

CLINICAL ASPECTS OF ANISEIKONIA. DR. E. H. CARLETON.

The correction of aniseikonia is evaluated from the clinical point of view by discussing a statistical summary of 300 cases in which patients had obtained relief through iseikonic prescriptions given by the eye clinic at Hanover, N. H. In 47 per cent, or nearly one-half of the cases, there was no significant change in the refractive correction (less than 0.37 diopter), while in only 23 per cent of the cases did the change in refraction exceed 0.37 diopter. In 21 per cent of the cases the refractive errors were small (less than 1 diopter in the maximum meridian). Ten patients with emmetropia exhibiting aniseikonia were found. With reference to the relationship of anisometropia to aniseikonia, it is stated that 15 per cent of the total number of patients were isometropic, while in 20 per cent the condition of aniseikonia was opposite to what would be expected from the condition of anisometropia. To present a clearer picture of the various combinations of refractive conditions that occur in conjunction with aniseikonia, four successful cases which illustrate these interrelations are presented: (1) a case of iseikonic correction without change in the refractive correction; (2) a case of emmetropia in which aniseikonia was demonstrated and corrected; (3) a case of anisometropia in which the iseikonic correction was opposite to that expected; (4) a case of anisometropia in which the correction of aniseikonia was in the same direction to the expected condition if it was the cause of the inequality of the ocular images. This case was of particular interest because the patient obtained complete relief from headaches of the migraine type from which she had suffered for sixteen years. From clinical experience it is believed that a large percentage of persons with anisometropia should wear iseikonic corrections. Clinical results so far obtained warrant the statement that aniseikonia is an important factor in binocular vision and that a clinical investigation of this anomaly should be made in all cases of functional disturbance of binocular vision as well as in cases in which relief has not been obtained by the correction of the refractive errors.

APPLICATION OF THE AFTER-IMAGE IN THE INVESTIGATION OF SQUINT. DR. A. BIELSCHOWSKY.

This article will appear in full in a later issue of the ARCHIVES.

CORRECTION

In the author's proof of the article entitled "A Method for the Correction of Entropion in Trachomatous Patients, with Particular Attention to the Esthetic Results," by Archimede Busacca, which was received after publication of the article in the November issue of the ARCHIVES, changes were made to correct errors made by the translator which were not observed by the author before the article was submitted for publication. These corrections have been made in the reprint, a copy of which may be obtained by writing to the publication office.

Book Reviews

The Intellectual Functions of the Frontal Lobe: A Study Based upon Observation of a Man After Partial Bilateral Frontal Lobectomy. By Richard M. Brickner, B.S., M.D., Assistant Professor of Neurology, College of Physicians and Surgeons; Attending Neurologist, Neurological Institute, New York. Price, $3.50. Pp. 354, with 8 anatomic photographs. New York: The Macmillan Company, 1936.

"The frontal lobe is, by common consent, the most dominant part of the brain. Yet in spite of its supreme position in the guidance of life, it is the least understood and perhaps also the least studied structure of the body." Thus writes Tilney, in his preface to Brickner's book, which is the history—the only one on record—of a man from whom a large portion of each frontal lobe had been removed because of an extensive meningioma and who survived for several years, leading a fairly well adjusted life.

The patient, aged 40, a successful member of the New York Stock Exchange, with many friends and a satisfactory family life, began to suffer from headache, impaired memory and absent-mindedness. The symptoms grew worse for a year, at the end of which time he fell into a coma. He was then operated on by Dr. Walter Dandy at the Johns Hopkins Hospital, who amputated each anterior lobe from a vertical line just anterior to Broca's area. The portions of the anterior lobes removed measured, respectively, 7 cm. and 7.5 cm. in the anteroposterior diameter. Broca's areas, the rolandic areas and the anterior and middle cerebral arteries were not disturbed. A year after the operations the patient came under Brickner's observation. Throughout a second year he was carefully studied neurologically and psychologically, and his mental status was compared with that described by his family and friends as existing before his illness.

Neurologic examinations made repeatedly in the second postoperative year gave negative results, except for the finding of a fine tremor of the head and hands, complete loss of smell on the left side and an almost complete loss of smell on the right. The eyes were normal. Four attacks of generalized clonic spasm occurred, but these were without focal signs.

Lesions of the frontal lobes have long been known to cause definite changes in character. Holmes, in 1931, distinguished three types, "one characterized by apathy and indifference, one by depression, intellectual enfeeblement, automaticity and incontinence, and one by restlessness, euphoria, lack of concern over the gravity of the situation, irritability, childishness, 'Witzelsucht' and marked egoism."

A year after the operations efforts were made to reeducate the patient, and detailed notes were kept describing his behavior. His own spoken words were written down, and these records, together with the records of the psychologic tests and their interpretation, make up the bulk of the volume.

The symptoms observed in the patient's intellectual sphere that had an emotional coloring were due to impairment of restraint and con-

sisted of boasting, mild hostility and the expression of angry, aggressive and puerile impulses. The symptoms observed in the intellectual sphere that did not have an emotional coloring were failure to synthesize memory pictures, difficulty in fixing the attention and impaired capacity to differentiate between the important and the unimportant. Also, there was impairment of memory for recent events and, because of this, a lack of learning capacity. A further group of symptoms included impairment of judgment, slow cerebration and *Witzelsucht.*

The jocular waggishness or facetiousness which is perhaps the most striking symptom of lesions of the frontal lobe was termed *Witzelsucht* by Oppenheim in 1890, and this name has since then been in general use. Golla in 1931 suggested that "facetiousness is simply a conscious defensive reaction when the patient dimly realizes that he is suffering from an inability to understand and react normally." It has been likened to the flow of jocularity often found in persons in the uninhibited alcoholic state. Brickner expresses the belief that it, like many other symptoms of lesions of the frontal lobe, is due merely to impaired restraint. This symptom is of interest to the ophthalmologist because when he finds pressure atrophy of one optic nerve, with or without papilledema of the other, together with *Witzelsucht,* the diagnosis of a tumor in the frontal lobe on the side of the atrophy is at once suggested.

On assembling the many symptoms presented by his patient Brickner found that the personality had lost no characteristics and had gained none, but that some were more pronounced than before the illness and others less so. He states the belief that all the symptoms can be referred to a single intellectual deficiency, namely, an impairment of the process of synthesis.

In summing up, Brickner comes to a number of conclusions, from which the following statements are extracted:

A. While the patient's symptoms are numerous, none of them indicates an alteration in the fundamental nature of any mental process, but only the impairment of its completeness. Hence the changes are fundamentally not qualitative but are quantitative.

B. Only one function is considered as primarily affected. This is the elaborate association or synthesis into complex structures of the simpler engrammic products (latent memory pictures) associated in the more posterior parts of the brain. There is a diminution in the amount of this synthesis which places a limit on the degree of attainable complexity of thought. Through this deficiency a variety of defects become manifest, and the personality appears to be greatly altered.

C. While many of the symptoms have an emotional coloring, there is nothing to indicate an emotional disturbance in a primary sense.

D. The deduction seems justified that the frontal lobes are not intellectual *centers* in any sense except, perhaps, a quantitative one and that they play no specialized rôle in intellectual function. They add to intellectual intricacy in a quantitative manner only, by increasing the number of possible associations between engrams which have already been aggregated to a complex degree in other parts of the nervous system.

WARD A. HOLDEN.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66, Boulevard Saint-Michel, Paris (6e).
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

International Ophthalmologic Congress

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Holland.
Place: Cairo. Time: December 1937.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33, Welbeck St., London, W., England.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. P. E. H. Adams, 6, Holywell, Oxford.
Secretary: Dr. Thomasina Belt, 13, Mitchell Ave., Jesmond, Newcastle-on-Tyne.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. Gordon M. Holmes, 9, Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27, Weymouth St., London, W. 1.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Time: July 8-10, 1939.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. Ransom Pickard, 31, East Southernhay, Exeter, England.
Secretary: Dr. A. Rugg-Gunn, 35, Harley St., London, W. 1.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

German Ophthalmological Society

President: Prof. Lohlein, Jena.
Secretary: Prof. A. Wagenmann, Heidelberg.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

Tsinan Ophthalmological Society

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. William L. Benedict, 102 Second Ave., S. W., Rochester, Minn.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Atlantic City. Time: June 7-11, 1937.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

American Ophthalmological Society

President: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Managing Director: Mr. Lewis H. Carris, 50 W. 50th St., New York.

SECTIONAL

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. E. S. Schmidt, 107 E. Walnut St., Green Bay.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

New England Ophthalmological Society

President: Dr. James J. Regan, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Road, Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. A. J. Ridges, Walker Bldg., Salt Lake City, Utah.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Place: Salt Lake City, Utah. Time: May 24-27, 1937.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. H. Klemptner, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, Virginia Mason Hospital, Seattle.
Place: Seattle. Time: January 1937.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. A. H. Pember, 500 W. Milwaukee St., Janesville, Wis.
Secretary-Treasurer: Dr. W. H. Elmer, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Robert Griswell, 707 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. L. H. Hohf, Yankton, S. D.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. O. B. McGillicuddy, 1908 Capitol Band Tower, Lansing, Mich.
Secretary-Treasurer: Dr. Maurice C. Loree, 120 W. Hillsdale St., Lansing, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Leslie R. Hazlett, 100 S. Main St., Butler.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Walter L. Hogan, 750 Main St., Hartford.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. B. H. Minchew, 701 Elizabeth St., Waycross, Ga.
Secretary-Treasurer: Dr. Edward S. Wright, 1001 Medical Arts Building, Atlanta, Ga.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. R. Dillinger, French Lick.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. James A. Downing, 406 Sixth Ave., Des Moines.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.
Place: Des Moines.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

Minnesota Academy of Ophthalmology and Oto-Laryngology

President: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.
Secretary-Treasurer: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. Edward S. Murphy, Northern Pacific Hospital, Missoula.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. C. Coulter Charlton, 124 S. Illinois Ave., Atlantic City.
Secretary: Dr. H. L. Harley, 124 S. Indiana Ave., Atlantic City.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Walter S. Atkinson, 168 Sterling St., Watertown.
Secretary: Dr. Marvin F. Jones, 121 E. 60th St., New York City.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. Burton W. Fassett, Geer Bldg., Durham.
Secretary-Treasurer: Dr. Casper W. Jennings, 332 N. Elm St., Greensboro.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. Trygve Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 514 6th St., Valley City.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary-Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. R. E. Houston, 103 E. North St., Greenville.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. W. W. Potter, 601 Walnut St., Knoxville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.
Place: Fort Worth. Time: Dec. 11 and 12, 1937.

Utah Ophthalmological Society

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Edwin W. Burton, University of Virginia, University.
Secretary-Treasurer: Dr. George G. Hankins, 202 Medical Arts Bldg., Newport News.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.
Secretary: Dr. J. E. Blaydes, First National Bank, Bluefield.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. B. E. Failing, 31 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark, N. J.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron.
Secretary-Treasurer: Dr. C. R. Andersen, First-Central Tower, Akron.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. William C. Warren Jr., 478 Peachtree St., Atlanta, Ga.
Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Jesse W. Downey Jr., 529 N. Charles St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Thurber LeWin, 112 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. G. Henry Mundt, 30 N. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. A. B. Bruner, 629 Euclid Ave., Cleveland.
Secretary: Dr. M. W. Jacoby, Hanna Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. F. W. Thomas, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. D. Emswiler, 370 E. Town St., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Hugh L. McLaurin, 1719 Pacific Ave., Dallas, Texas.
Secretary: Dr. Maxwell Thomas, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. A. W. Greene, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Joseph L. Holohan, 317 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 500 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Henry C. Haden, 1914 Travis St., Houston, Texas.
Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. J. C. Daniel, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Davis, 1101 Grand Ave., Kansas City, Mo.
Secretary: Dr. Byron Black, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. K. C. Brandenburg, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Oto-Laryngology

President: Dr. William A. Boyce, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Arthur M. Zinkham, 815 Connecticut Ave., Washington.
Secretary: Dr. E. J. Cummings, 1835 I St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Hychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. Thomas A. Judge, 735 N. Water St., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 208 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Minneapolis Ophthalmological Society

Chairman: Each member in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

Montgomery County Medical Society

Chairman: Dr. W. J. Blackburn, 663 Reibold Bldg., Dayton, O.
Secretary-Treasurer: Dr. F. J. Driscoll, 986 Reibold Bldg., Dayton, O.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Kate S. Zerfoss, 119, 7th Ave., N., Nashville, Tenn.
Secretary-Treasurer: Dr. Fowler Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. John H. Dunnington, 30 W. 59th St., New York.
Secretary: Dr. LaGrand H. Hardy, 30 E. 40th St. New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Nueces County Eye, Ear, Nose and Throat Society

Chairman: Dr. A. W. Davidson, City National Bank Bldg., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 720 Medical-Professional Bldg., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. W. H. Stokes, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. E. C. Reynolds, 657 Main Ave., Passaic, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 80 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Falk Clinic. Time: 4 p. m., second Friday of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Robert H. Courtney, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Carl T. Eber, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, 508 N. Grand Ave., St. Louis.
Place: Oscar Johnson Institute Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Joseph W. Crawford, 490 Post St., San Francisco.
Secretary: Dr. Russell Fletcher, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. John T. Crebbin, 624 Travis St., Shreveport, La.
Secretary-Treasurer: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. A. Veasey Jr., 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Philip B. Green, Old National Bank Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Samuel Mortimer Lyon, 122 Bloor St., W. Toronto.
Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. James M. Greear Jr., 1740 M St., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Ernest Sheppard, 927 17th St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.